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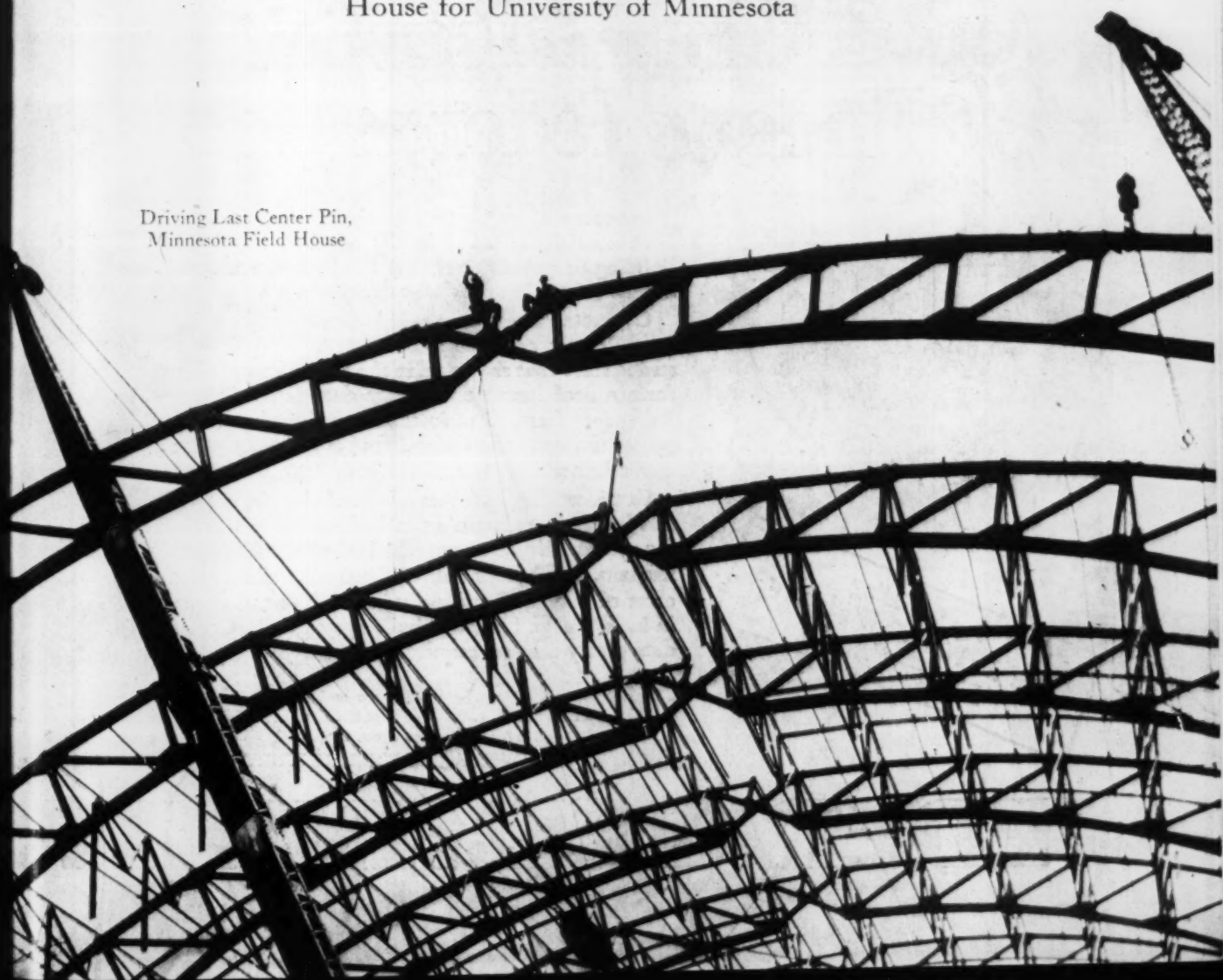
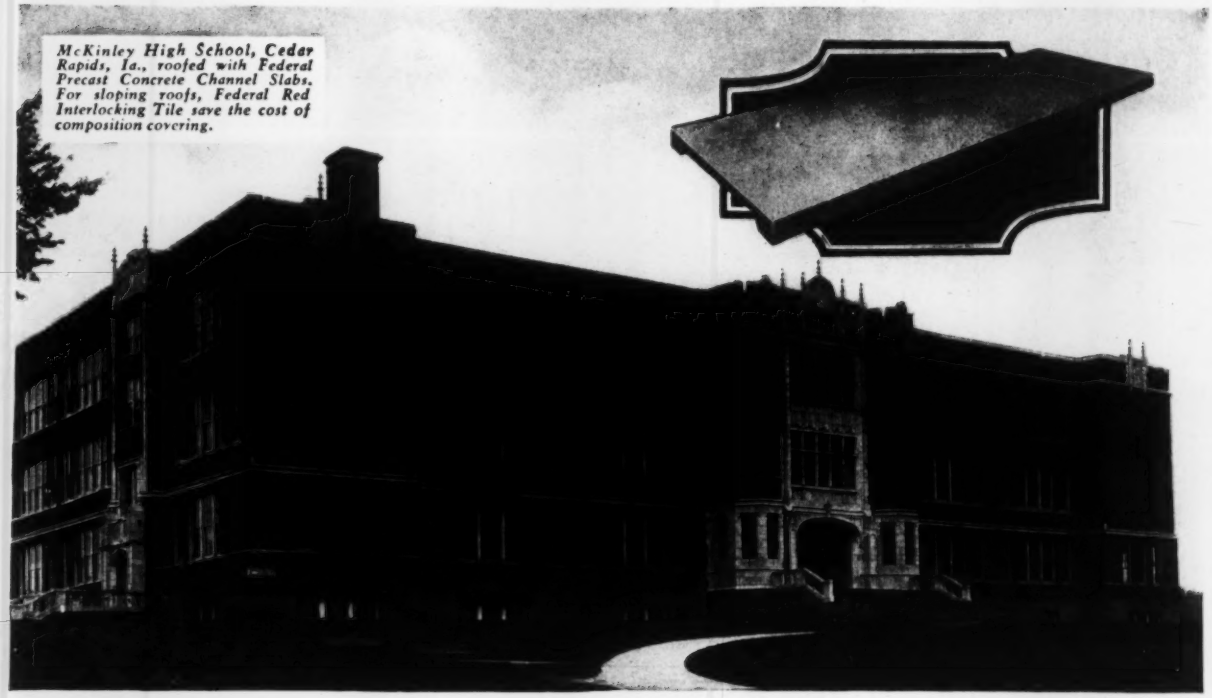
Fourteen 220-ft. Three-Hinged Steel Arch Trusses Form Main Framework of Field House for University of Minnesota



Driving Last Center Pin, Minnesota Field House



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Interstate Water Protection

ELASTIC as have been the interstate commerce and general welfare provisions of the Constitution, they have not yet been stretched to give Congress or any federal administrative agency power to stop the pollution of interstate waters. In the absence of federal control two courses are open as regards interstate waters: Compacts or treaties between two or more states, subject to approval by Congress, and working agreements between state agencies which have control within their own domains and are willing to use those powers for the benefit of neighboring states. No interstate treaty of the kind just indicated exists, but there is co-operation among state health departments in the Delaware and the Ohio River basins and the Great Lakes, the latter as noted in our issue of March 22, 1928, p. 493. Since state legislation goes farther as regards sewage pollution than as regards manufacturing wastes, correspondingly more may be expected in the field of the first than of the second. At least this is true as far as the exercise of legal powers is concerned. In view of the general lack of legislative power to control pollution by industrial wastes and of considerable variation of power over sewage pollution in the various states, all these efforts to control water pollution are largely dependent on the co-operation of both industries and cities. Recognition of this by all concerned is one of the most promising features of these federations to lessen the pollution of interstate waters.

Traffic and Planning

THAT city of superlatives, Los Angeles, seems to have the largest, the brightest or the most of almost everything, but also the highest rate of traffic accidents, as we had occasion to note some years ago. The situation has changed but little since then, as is indicated by the fact that recent press reports give the traffic fatalities in the county as 54 for January and 64 for February, a period two days shorter. This alarmingly high mortality is not due to absence of traffic regulations or to lax enforcement; on the contrary, severe penalties for even minor violations have given Los Angeles an unenviable reputation with visiting motorists. It happens that most of the fatalities occur outside the central business district, whose narrow, traffic congested streets make rush-hour traffic very slow. The density of motor vehicle traffic, the large areas over which the city has spread and the considerable number of outlying trading centers that have resulted doubtless all contribute to the high accident rate. The fault lies largely with the layout of the city streets. If the present intensity of motor traffic could have been foreseen, there would surely have been wider streets, closer spacing, better planned intersections and more alleys for commercial vehicles, and the present gruesome average of two traffic deaths per day would not be recorded. Traffic studies have helped some, and two years of pedestrian control in the business district have reduced the fatality rate. But with the city built up as now, all that can be done is merely palliative. A study of Los Angeles conditions offers an example and an object lesson to those cities still able to do economical planning for future growth.

Greater Building Heights

CITY growth within the past few years reveals a well-marked increase in average height of metropolitan office buildings. The same phenomenon may be noted in each one of our million-population cities. Quite recently there has come also an increase of maximum building heights, which are advancing into a new range. Not long ago 30 to 35 stories was the effective maximum, but now 40-story projects are numerous and within the last two months several pyramid or tower buildings of some 50 stories have been announced. One of these is planned for 64 stories, a height of 800 ft., topping by a safe margin the Woolworth tower, which is still the world's tallest office structure. Thus is the skyscraper continuing its onward and upward march. Only two decades have passed since the erection of the famous Singer, Metropolitan and Woolworth buildings. But while these older works of surpassing boldness were mainly monuments to family or commercial pride, the current projects have a purely economic basis. Each primarily owes its existence to the fundamental truth that rising property values and constricted building areas justify increasingly taller structures for adequate investment return. But there are some essential auxiliary factors. Due to the resources of modern engineering, steel framework and long-run elevators are practicable to heights far beyond those yet attained. Again, it has developed that building costs do not increase greatly with height. And finally, business men nowadays will travel to a 50-story height as readily as to one of 25 stories, and will pay as much or more rental at the higher level. With these conditions in control, the limit of height increase is not subject to present prophecy. We may be certain, at any rate, that the limit will not be set by technical inability to build higher.

Sweden's Road Show

SWEDEN proposes to have a road show. The country has now reached a position where the volume and variety of road machinery produced by its manufacturers, added to the highly advanced construction technique of its highway engineers, appear to warrant the formality of a yearly educational demonstration such as the annual road show of the American Road Builders Association has become on this side of the ocean. The exhibition, which is sponsored by road associations and motor vehicle clubs, will be held this spring in connection with the great Goteborg Fair of May 12 to 20, and it is stated

that in the exhibition hall of 53,820 sq.ft., with its gravel floor, "streets and roads can be built and torn up again and asphalt and other surfacing can be applied and other practical demonstrations given of machinery and materials." The significance of this occasion is that it reflects a development which in the last few years has put Scandanavian road-building practices in the front rank of highway engineering anywhere in the world. Today there can be found in Sweden and Denmark concrete roads which in design, concrete control and machine fabrication suffer nothing in comparison with the proudest examples of America's great concrete road-building states. Today, too, Scandanavian manufacturers are producing all the kinds of machinery for road building and virtually every kind of road-building material, except asphalt, that are commonly used in America. And not the least pleasing thought to American road builders is that Swedish engineers have found much in American design and methods which they coulld adopt.

Weather Predictions

STORMS are a constant reminder of the weakness of present-day science with respect to weather. The science of meteorology, if indeed it be a science, has so far failed utterly to progress toward the prediction of weather. We do not refer to the "tomorrow" forecasts, though these are regarded with rather diverse sentiments, depending upon the individual concerned. Even the occasional two-day forecasts may be excepted, though they are distinctly more dubious. The matter now in question is the so-called long-range forecasting, a week or a month in advance. Recently the United States Weather Bureau felt moved to defend its reputation against the claims of private long-range forecasters—a rare happening, for scientific institutions do not often enter into dispute with empiricism or charlatanry. On the bureau's statement, the present fact is that despite any tempting surmises as to the effect of various cosmic happenings upon weather, knowledge of weather is still confined to the moment's observation, slightly supplemented by telegraphic information of the weather farther back along the usual track of atmospheric disturbances. There appears to be little prospect for better knowledge in the early future, moreover. Therefore the problems of engineers and others who depend on weather will continue to be subject to pure chance—or shrewd guess. Rainfalls and freezing spells, storms and drouths, remain Acts of God. Thus the weather observer must perforce resign himself to a rôle of little honor. But it is fair to remark that his difficulties are enhanced by the undiscriminating attitude of the public, or, more correctly speaking, of the newspapers. The latter almost daily deal with weather in a way that is bound to confuse and discourage sound thinking on the part of the public. "Today was the coldest day of this date for twenty years past," they will print, regardless of the fact that the comparison is wholly without meaning. That the month as a whole was coldest in twenty, or in twelve, years does not seem to have the news value of the one-day sensation statement; yet this fact is of real significance and would do its part toward building up a proper appraisal of weather changes and their meaning. A sounder attitude of newspapers toward weather news and records would, we think, contribute more to the growth of public understanding of weather-bureau work than pages of defence against charlatans.

A Call to Construction

WHAT does the Mississippi flood-control problem mean to the construction industry? The mere magnitude of the work to be done creates radically new problems. Whether the work is done by contract or by direct labor, it is imperative that men with experience in heavy construction, in handling earth by the millions of yards, concrete by the hundred thousand cubic yards, and piles by the untold thousands, shall adapt existing machines and methods to more intensive mass-production than has yet been undertaken. Here is a formidable task for those who represent construction—and not least for the manufacturers of construction machinery.

Of the indefinite hundreds of millions that the Mississippi work will cost, two-thirds must be spent for levee and spillway construction, and one-third for revetment. The levee work is to be completed in ten years, so the planners intend, perhaps with a measure of optimism. Translated into physical terms, into yardage, the task is of prodigious dimensions. Not only its size, however, but also its new character calls for a re-appraisal of present construction methods. An article on another page indicates to what extent present equipment has reached its limit and points out the possibility of advance.

Just as wheelbarrow, slip scraper and even elevating grader and tractor-hauled trailer have had to give way to steam shovel, dragline, tower machine and suction dredge for large-volume levee construction at high speed, so these in turn may have to give way now. The enlarged levees with greatly widened base are sure to require fundamental change in types of plant. In many cases borrow will not be available in the existing batture—the area of bank between toe of levee and river bank. Longer-reach machines are therefore inevitable.

It is instructive to think back to the time when the Sanitary District of Chicago excavated its diversion channel, some 30 years ago. Dozens of new kinds of plant and methods of earth handling were developed. The size of the enterprise stimulated the thought of the best minds in the construction industry, and an epoch was marked in the history of construction. For the first time in a large way excavation was carried on by cableways, by cantilever cranes, by slack-line excavators and rock channelers. There is every prospect that a corresponding epoch will be marked by the coming work in the Mississippi Valley.

Not alone the building of the levees but perhaps even more the revetment work is of new kind. Brush mattresses will have to be abandoned, because as brought out by Mr. DeBerard a few weeks ago (March 15, p. 434), there is not enough brush for the large volume of work required. It will doubtless be necessary to resort to concrete mats, using machines that can work at all stages of the river and throughout the year, but it is not to be expected that the machines so far developed by government engineers will survive without radical improvement. The highest possibilities of the cement-making art and of the concrete manufacturer will be equally necessary. The call upon the munitions-factories of construction is as urgent as in the matter of levees.

Thus the construction industry faces a significant opportunity in the Mississippi flood control. The task to be carried out calls for the full power of 1928 engineering, in the planning of machines as well as methods, to the end of achieving excellence, speed and economy of result.

British Track Criticised

FOR many years it has been rather generally assumed as an established fact that the track of English railways is more substantial than that of American railways, especially in its relation to the lighter wheel loads of the former, and also that it has a high standard of maintenance. In fact, it has been rather a habit of English engineers to criticise the "lightness" of American railway track, though the critics apparently have known little of our modern main-line construction. Under these circumstances it must have been an unpleasant shock to the engineers of English railways to be told by a government inspecting engineer: "The necessity for permanently strengthening the roadbed in order to meet present-day traffic conditions does not appear to have been fully realized. Loading has increased, and heavier and more powerful locomotives have been built. Betterment in the type of roadbed and class of maintenance becomes correspondingly of importance."

This warning is given in the report on a disastrous derailment of a fast train by which thirteen persons were killed. The criticism included both the construction and the maintenance of track, for the track was insufficiently ballasted and a survey of the curve on which the accident happened showed a considerable variation in super-elevation, causing a wavy profile of the outer rail. Such irregularity may be more serious than excessive elevation, as it sets up both vertical and lateral swaying of the spring-borne loads of the engine and cars. Specifically, the report says:

"Though the condition and strength of the rails, fastenings and sleepers [ties] were adequate, the drainage, the quality of ballast (particularly the bottom ballast), the gage and the level of the rails could not be described as first class. The road had not a sufficiently firm foundation to carry such heavy loads at high speed as had passed over it, with the result that it had been gradually knocked down. It is possible that the heavy rainfall had caused the road to go down rapidly. The permanent-way staff [maintenance-of-way staff] either had not realized the extent to which the road had suffered under this traffic and wet weather, or were unable to maintain it. Sufficient attention does not appear to be paid to instructions with regard to super-elevation on curves, and to the necessity for maintaining it. The erection of permanent pillars [monuments] showing the cant [elevation] required, and the supply to gangers [section foremen] of combined gage and level reading tools, would appear to be advisable. More frequent riding on engines at high speed by permanent-way officers and inspectors, particularly in wet weather, would keep them better informed of the condition of the roadbed and the need for action."

It may be pointed out that in recent years there has been a great increase in size and weight of locomotives and in wheel loads on English railways, but with apparently little change in track construction. In the English press discussion of the accident in question has centered on the locomotive rather than on the track, as this engine was of the tank or tenderless type and there is periodical discussion in England as to the suitability of such engines for high-speed main-line service. However, investigation by means of tests of similar engines eliminated the engine as a cause of the accident. since both tank and tender engines on the line where the accident occurred were found to develop "rolling" motion due to imperfections of the track, caused, it was considered, by inefficient tamping or defective drainage. The tank-engine question is not a factor in track conditions in this country, since engines of this type are not used in main-line traffic.

That this one accident will lead to any change in track design on English railways is not probable. But its cause and the warnings voiced in the government engineer's report should result in bringing the work and discipline of their maintenance departments to a higher standard. On the other hand, there is a lesson in all this for the American engineer, since it must be admitted that track is sometimes hardly adequate for the loads imposed upon it and not adequate for economical maintenance under such loads. Both American and English railways are in the same boat and need to consider their own improvements rather than to criticise their transatlantic fellows.

Regional Self-Help

AS CLOSE upon the devastation of the Vermont floods as could be expected in view of the fact that attention had to be given first to relief and to the first stages of reconstruction comes the announcement of the creation of an engineering advisory commission to make a flood-control program for submission to the 1929 Legislature. Except for co-operation from two branches of the U. S. Geological Survey, which will be no greater than the federal assistance in stream-flow investigations already extended in other states, the Vermont flood-control studies will be financed and executed from within the state. Presumably self-help will also be the rule when control works are undertaken—unless by then Congress has gone so far in flood-control work along the Mississippi and its tributaries as to make similar aid elsewhere the only logical course. Vermont is not alone in applying self-help to flood-control studies.

Simultaneously with the announcement of the Vermont committee, recorded in our current news section of last week, comes a well-conceived and well-executed "Report on Control of Floods in Northern New York Rivers"—streams on the western slope of the Adirondacks and flowing westerly and northwesterly into Lake Ontario and the St. Lawrence River. This report is notable both in itself and because its inception followed so promptly after the New England floods, having been authorized Nov. 30, 1927, by a committee of mayors representing Ogdensburg, Watertown, Canton, Potsdam and Malone, with a view to forestalling such ruin as had just taken place in Vermont and elsewhere in New England. Available stream-flow data and local conditions as to possible floods of a half-dozen rivers are reviewed by an engineer, Edwin S. Cullings, Watertown, N. Y., aided by probability studies made by Allen Hazen, New York City. Existing and projected regulating reservoirs in the Adirondacks are considered. As to the future, the indications in both northern New York and Vermont are that power development and flood control will go hand in hand.

New York State already has legislation that authorizes the creation of river regulation districts, with assessment of costs on property benefited. Presumably the Vermont committee will consider that legislation and its results. The action thus far taken in both regions not only promises results of local benefit but also suggests the extension of such self-help efforts in other parts of the country.

Athletic Field House for Minnesota University

Fourteen Three-Hinged Steel Arch Trusses of 220-Ft. Span and 100-Ft. Height Form Main Framework of a Building 440 Ft. Long Recently Completed at Minneapolis

By George H. Herrold
Managing Director and Engineer, St. Paul City Planning Board, St. Paul, Minn.

THE NEW field house for the University of Minnesota at Minneapolis is a structure 440 ft. long and 236 ft. wide. The main structural frame of fourteen three-hinged steel arch trusses, 100 ft. high at the center and spaced approximately 30 ft. apart along the building, is inclosed in brickwork and covered with a steel-plate roof insulated and waterproofed.

Double-deck balconies supported in the trusses provide unobstructed vision of the arena for 8,500 spectators, and the ultimate seating capacity of the building can be increased to about 30,000 by using extra portable seats if the nature of the entertainment permits. Besides its several interesting structural details, this field house represents a type of structure becoming necessary in many colleges as such indoor sports as basketball annually gain in popularity. At Minnesota, the house serves the additional purpose of providing space for year-round practice of those outdoor sports that are affected by the rigorous climate.

The field house is on the main campus directly opposite the large memorial stadium erected three years ago. The construction is financed by proceeds from athletic events, most of the funds coming from football. The total cost, exclusive of the property, is $630,000. An interior view of the partly completed structure is given in Fig. 1. The basketball floor is placed near one end and is removable. A cinder track is planned at the front edge of the lower balcony. On the first floor at one end of the building under the balcony are located the entrance lobby, ticket offices and locker rooms. On the second floor are four large apparatus storage rooms. A unit type heating system is planned with steam-coil chests, fans, blowers and motors located under the upper balconies, with metal ducts extending up under the roof to carry the heat to all parts of the building. This system is designed to provide a temperature of 60 deg. F. when the temperature outside is 15 below zero. Steam is provided by the university's central plant.

Trusses and End Walls—The arch trusses that carry the roof and balconies have a pin-point span of 220 ft. and a vertical distance of 100 ft. from the 4½-in. bottom pins to the 7½-in. top pin. The radius of curvature of the upper chord is 138 ft. and of the lower chord 105 ft. Each truss has its back post vertical to a height of about 43 ft. above the bottom pins. The chord and web members are Bethlehem shapes, H, G and I sections, all 12 in. in depth, but varying in weight from 28½ to 119½ lb. In combining these three types of sections, a large selection of details was possible to suit the various stresses. In addition, the uniform 12-in. dimension made simple gusset-plate joints possible. The chords were made up in two, three and four panel lengths (panel lengths 10 ft. and 12 ft.), depending upon the change in section. Each truss rests on a cast-steel base bolted to concrete footings 12 ft. square and 4 ft. deep. The horizontal thrust on the lower pins is resisted by double 12-in. channel ties placed 3 ft. below the ground and incased in concrete. This detail is illustrated in Fig. 4.

These main arch trusses were designed for all possible combinations of loaded balconies and of snow and wind loads. The stresses used in the design were those recommended by the A.I.S.C. except for shop rivets, where bearing was specified at 25,000 lb. and single shear at 12,000 lb.; for field rivets the values were 80 per cent of the foregoing.

The high end brick walls are stiffened by steel columns of the plate-girder type, 3 ft. deep, anchored to concrete foundations at the bottom and tied together with steel wall trusses at the top. The wall trusses are connected to the main arch trusses by deep purlin trusses.

Because the steel framing of the roof was riveted for its entire 440-ft. length, provision for expansion and contraction was made by weatherproof expansion key joints in the four corners of the inclosing brick walls. It is planned that the embedded columns and trusses in each end wall will so stiffen it as to allow it to hinge about its base in one unit. Three weatherproof key

FIG. 1—INTERIOR OF NEW FIELD HOUSE, UNIVERSITY OF MINNESOTA
Arch trusses support walls and roofs and carry double deck balconies in building 440 ft. long and 236 ft. wide.

joints were also distributed in the two long brick side walls extending for the full height of the wall.

Balconies—On each side of the building a double-deck balcony extends out from the side walls approximately 35 ft. These side balconies are entirely supported on the main steel trusses, whereas for the balcony which extends across the full width at one end, it is necessary to use columns. The side balconies are supported at the rear by I-beams carried by the back posts of the arch trusses. At the front end the balconies cantilever over parallel-chord trusses carried by the inner chord of the arch trusses. The balcony framing is cross-braced against both sway and forward movement.

The possible live load on the balcony was estimated by computing the number of persons that could be seated by crowding and then increasing such a static load by 155 per cent for impact. This value was obtained from a series of tests conducted by Prof. A. H. Fuller at Iowa State College. The 155 per cent value was the most severe impact from cheering students teetering on their toes at five-second intervals. The design was made for a live load of 125 lb. per sq.ft., plus 25 lb. per sq.ft. dead load.

Roof—The main roof framing consists of longitudinal trusses between the panel points of the arch trusses. These longitudinal trusses carry 8-in. channel purlins at their third points, and these channels in turn support 5-in. channel purlins spaced approximately 5 ft. apart. Alternate bays of the main trusses are braced at the upper chords by diagonal bracing. Over the purlins and clipped to them is placed a roof of copper-bearing steel plates curved at the factory to suit the radius of the roof. To guard against heat loss from the inside a 1-in. thickness of patented insulation was mopped over the steel decking and then covered with a layer of 15-lb. felt lapped 3 in. After another mopping, black slate-surface asphalt roofing felt 32 in. wide was applied with a 17-in. selvage. The selvage was solid mopped and each layer of the felt as it was laid was fastened through the steel decking by screws, one to each 5 sq.ft. This fastening of the roof to the steel decking was thought to be necessary to guard against sliding of the roofing on the curved parts during warm weather. The total dead load of the complete roof is only 6 lb. per sq.ft.

The roof was designed for a horizontal wind pressure of 30 lb. per sq.ft. on the steepest part and 17½ lb. per sq.ft. on the flat part; 10 lb. of the allowance on the flat roof was for sleet and ice. The snow load was figured at

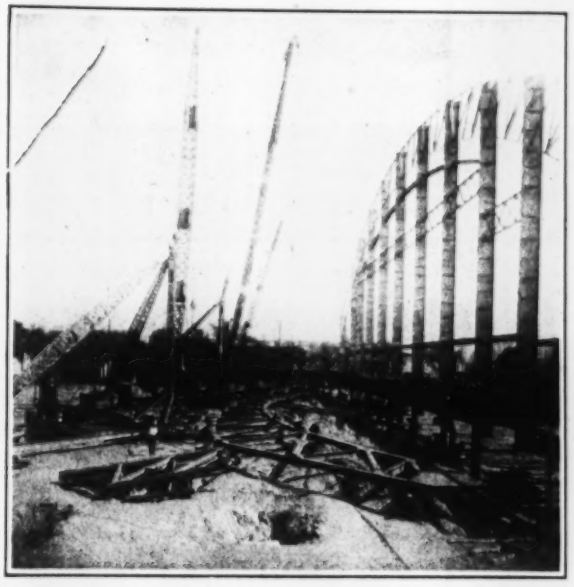


FIG. 3—DERRICK IN POSITION FOR RAISING ARCH TRUSS OF 220-FT. SPAN, 100 FT. HIGH

The method here shown of raising the two halves was found to be awkward and the rest of the arches were erected in four units, joints being made at the crown and at the top of the back post.

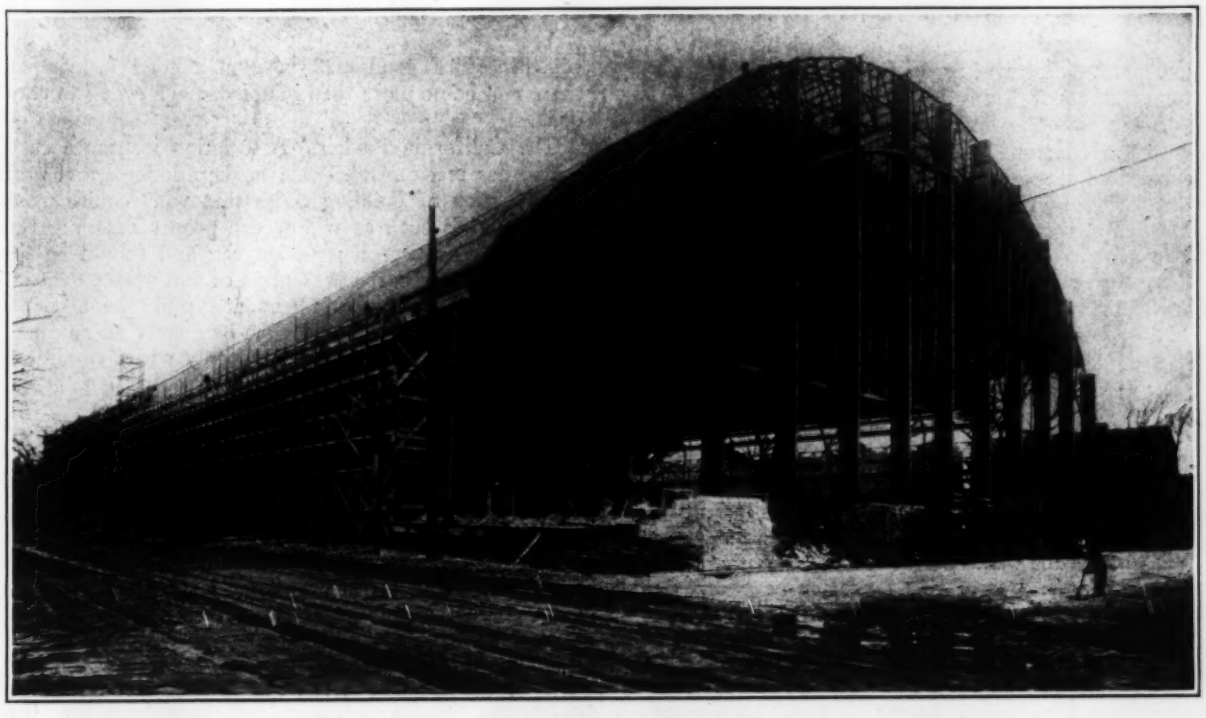


FIG. 2—PARTLY COMPLETED FIELD HOUSE, UNIVERSITY OF MINNESOTA

Brick inclosure walls partly in place. Note heavy plate girder column construction in end walls designed to resist expansion of structural framework 440 ft. long.

40 lb. per sq.ft. on the flat part and 10 lb. per sq.ft. on the steepest part of the roof.

Erection—The main trusses were delivered to the job with each half in four pieces. These halves were then riveted on the ground into two pieces, the joint occurring on a line level with the top of the back post. The lower section was lifted, the bottom pin set, and the assembly blocked and guyed in place. The other part of the half

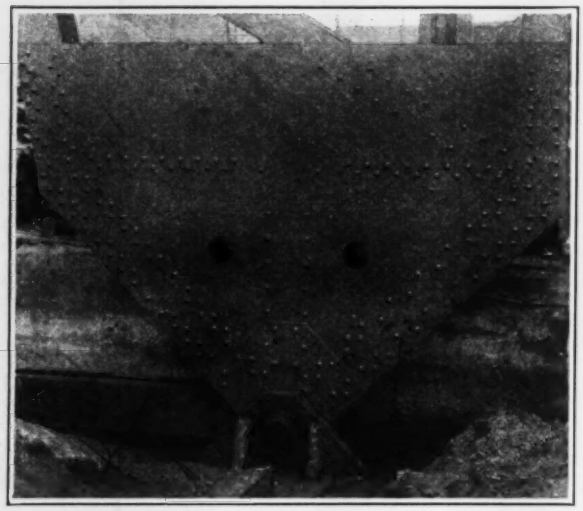


FIG. 4—BOTTOM PIN DETAIL, ARCH TRUSS, UNIVERSITY OF MINNESOTA FIELD HOUSE

truss was then raised and the joint connection made. While the first half of the truss was held by the derrick boom, the other half was assembled and raised in the same manner by another derrick boom. A third derrick boom was used to place and assemble parts of another truss on the ground while these two were being used for erection.

The contract for the building was let May 10, 1927, and the building was ready for use Feb. 4, 1928. The total steel tonnage was 2,300 tons.

Personnel—The architect for the field house was Clarence H. Johnston, St. Paul. E. S. Nelson laid out and supervised the structural design, and the details were worked out by C. Warren Durr, office engineer. W. B. Marschner was the architect's superintendent on the job. The general contractor was the Madsen Construction Company, and the steel was fabricated by the Minneapolis Steel & Machinery Company, both of Minneapolis. The steel was erected by Walter De Freres, St. Paul.

Cape Cod Canal Passes to Control of the United States

Purchase of the Cape Cod Canal by the United States was consummated on March 30, and by direction of the Secretary of War, the Chief of Engineers instructed the U. S. District Engineer at Boston to take possession of the canal in the name of the United States at noon on March 31. The canal will hereafter be operated, toll free, as a part of the system of national waterways, under the provisions of Section 6 of the river and harbor act approved March 3, 1909.

Acquisition of the Cape Cod Canal by the federal government was authorized by the river and harbor act approved Jan. 21, 1927.

Quake Insurance Not Essential to Safe Financing of Buildings

Proper Design and Foundations Most Important—Having These, Only Minor Damage Can Result From Major Quakes

THE EFFECT of high earthquake insurance rates on building construction was discussed recently in a paper before the San Francisco Chapter, American Institute of Architects, by Paul A. Pflueger, vice-president of the Humboldt Bank, San Francisco. The paper outlined recent changes in financing building construction, particularly on the Pacific Coast, that have resulted from the three increases in earthquake insurance rates, the last of which was so drastic as to make insurance of this sort prohibitive in many cases. A tabulation of these rates appeared in *Engineering News-Record*, July 21, 1927, p. 116. In reviewing the matter, Mr. Pflueger made some constructive suggestions from the viewpoint of a banker, which are summarized as follows:

Assuming that these latest rates are justifiable, their adoption by the insurance companies has shown definitely that dependence upon such insurance is unnecessary and that it is, in fact, an economic waste. Banks and bond underwriters can assist materially by so arranging their requirements that primary emphasis shall be placed on proper building construction instead of on the demand for earthquake insurance, as has been the case recently.

When earthquakes occur, the principal cause of property damage is the cracking or collapse of buildings that have been improperly designed, built of inferior materials or inadequately braced and tied together for the type of foundation on which they are located. Capable architects and structural engineers point out that buildings of nearly any type or class can be and have been constructed to withstand shocks of the severest tendency of which there is record. Provided the superstructure is suited to the soil conditions, properly planned, braced and constructed of good materials, on a good foundation, there will be no more than minor damage even in major quakes.

The California Bankers' Association insurance committee has recommended that bankers indorse and urge the adoption of building codes that will require plans and materials such as will secure proper building construction. Proper construction can and should be the dominant factor in the prevention of earthquake damage. If this high construction standard could be attained, earthquake insurance would then be merely an auxiliary or alternative measure to be used only where conditions did not warrant dependence upon structural strength.

The same bankers' committee has concluded that institutions making loans on improved real estate could with reasonable safety waive earthquake insurance coverage (1) when the loan is upon improvement constructed of wood frame of less than three stories in height and (2) on all classes of loans when the improvement is properly constructed to resist damage by earthquakes as evidenced by a certificate from an engineer recommended by the American Society of Civil Engineers. Such certification should be made to include the consideration of foundation conditions, of course, and, in the case of construction loans, supervision satisfactory to the lender should be maintained throughout the construction period.

Cincinnati Engine Terminal; Big Four Railway

Steel and Creosoted Timber Framing for Buildings—Concrete Platform for Washing Engines—Ashpits of Water-Filled Type—Layout and Facilities

A $3,800,000 improvement to the Riverside freight yards of the Cleveland, Cincinnati, Chicago & St. Louis Railway at Cincinnati, Ohio, is part of extensive modernizing of railway freight facilities at that city in connection with the new union passenger station, as noted in *Engineering News-Record* of Jan. 5, p. 18. This Riverside work includes reconstruction of the engine terminal and car-repair yard and a rearrangement and extension of the freight yard. It includes also an incidental but important straightening of the main line, in conjunction with a similar improvement of the Baltimore & Ohio Railroad, which lies between the former road and the bank of the Ohio River. The site is about 4 miles west of the present union passenger station, and the freight yard is used partly as a terminal yard for the through trains on the Chicago Division and partly for handling transfer and classification of local business at Cincinnati. All of this yard work is done by flat switching.

To permit of straightening the main line it was necessary to place the engine terminal a little west of its original location. This involved setting a portion of it at the foot of a steep hillside, excavation for the toe of which led to some trouble from sliding ground. One street passing through the site of the engine terminal was relocated west of the improvement. Three streets interfering with the yard development at the east end were vacated in part and a new street, ¾ mile in length, was constructed south of the viaduct at the east end of the yards to an existing street. Four grade crossings over the main lines of the two railroads were eliminated by these street changes.

General Layout—A general plan of the terminal is shown in Fig. 2. Engines normally enter and leave the terminal at the east end, where two inbound and two outbound tracks are provided. There is also an engine lead at the west end, for the use of engines working at the west end of the yard and of engines departing with trains to the west. Inbound or arriving engines, entering at the east end, stop first at the coaling station, where sand pipes and water columns are also located. They then proceed to the ashpits, to have the fires dropped or cleaned, after which they move to a concrete washing platform. After being cleaned they proceed to the turntable and may be put in the roundhouse for storage or light repairs. Engines that are not required for immediate service or that are to be held in temporary storage may be placed on three parallel parking tracks, spaced 15 ft. c. to c. and having capacity for nineteen engines. About 75 engines are handled daily at this terminal, increasing to 85 per day under maximum conditions.

A "ready" track between the ashpits and outbound lead is for holding engines that have been serviced and are ready to depart from the terminal. There is also a house track extending to the storehouse and served by a 3-ton hand-power jib crane for handling wheels and other materials. At the west end are two eleven-car tracks, 13 ft. c. to c., for bad-order cars which require to have their loads transferred. A coal track extends over the bunker of the boiler house and a supply track serves the water-softening plant. All these are stub tracks, but there is also a double-end track for the wrecking or relief train and an enginehouse lead track extends from the turntable to a main track connection.

The car-repair yard, located between the engine leads and the freight yard, has eleven stub tracks opening from a ladder track and holding four to 24 cars each, with a total capacity of 164 cars. The repair tracks, spaced alternately 18 and 22 ft. c. to c., are served by lorry tracks of standard gage for push cars handling materials. These material tracks are placed in the 22-ft. spacing and are connected by small turntables with tracks extending to the repair shop and wheel storage.

All ladders, switching leads, engine running tracks and roundhouse tracks are laid with 90-lb. rails. Body tracks in the yards are laid with 90- or 80-lb. rails. The turnouts have 16½-ft. switch rails and No. 10 or No. 8 frogs, while the ladder tracks have angles of 8 deg. 5 min. for the repair yard and 6½ to 9½ deg. for the classification yards.

Coal and Water Supply—Near the entrance to the yard is a concrete coaling station having a bin capacity of 500 tons and serving the four inbound and outbound tracks. It is supplied from a hopper on a stub track for drop-bottom cars, an electrically operated conveyor taking coal from the track hopper to the storage bins. Just east of this coaling station is the sand storage and drying plant. Dry sand is blown by compressed air to a 10-ton bin above the coal bin, from which it is delivered to the engines by pipes with swinging spouts.

Water is pumped from the Ohio River to a water-softening plant having a capacity of 40,000 gal. per hour. The treated water flows by gravity to a 300,000-gal. steel

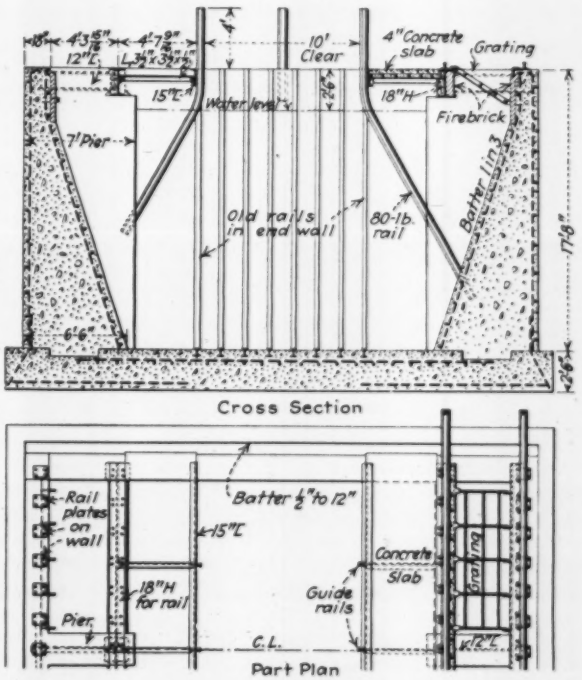


FIG. 1—WATER-FILLED ASHPIT

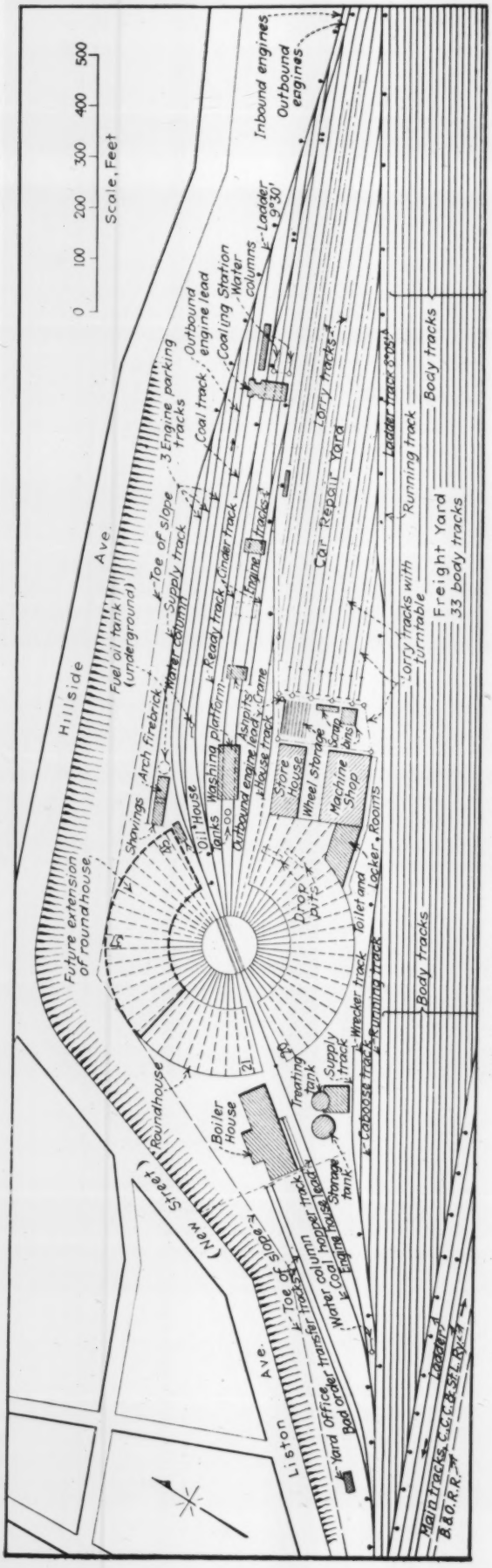


FIG. 2—ENGINE TERMINAL AT CINCINNATI; C., C., C. & ST. L. RY.

storage tank, from which it is piped through the terminal. Two water columns at the coaling station serve the four tracks also served by the coaling station; a water column near the roundhouse serves the second outbound track, another at the west end serves the enginehouse lead, and a fifth column about 1,500 ft. east of the coaling station serves engines in that vicinity.

Ashpits—Across the two inbound engine tracks are two water-type ashpits, 21x30 ft., spaced 250 ft. c. to c., as shown on the plan. A third pit will be built between them, when neccessity requires, so that six engines can have their fires cleaned simultaneously. As the pits are short, the engines must be spotted in position, and the capacity of each pit is limited to two engines discharging ashes at any one time. However, the storage capacity of the pits is such that they need be emptied only once or twice per day. With this type of pit the cost is considerably less than for longitudinal or continuous pits for the same number of engines handled.

At the ashpits the two inbound tracks are 25 ft. c. to c. and beyond each one is a stub track at 15-ft. spacing, outside the pits, for cinder cars. It was proposed originally to handle the ashes by a grab bucket from an overhead traveling crane on a steel-frame runway, the crane spanning the four tracks. Under the present plan a locomotive crane on either of the ash tracks will pick up the ashes from the pits with a grab bucket and load them into cars for removal.

These pits, Fig. 1, are 17 ft. 8 in. deep, with reinforced-concrete walls, the sides having a steep slope of 1 on 3. Outside of each engine track is a concrete platform for the engine hostlers or cleaners, leaving an opening 10 ft. wide for operating the bucket. Curved 80-lb. rails support the overhanging frame for the platform and serve as guides to prevent the buckets from catching under the platforms. The end walls and the bottom are protected from damage by the bucket by means of rails embedded in the concrete with their heads projecting $\frac{1}{2}$ in. above the surface. At one end of the pit are the inlet valve-box and the overflow chamber.

Each track has one rail on the side wall, secured by clips held in place by anchor bolts. The other rail is carried by an 18-in. H-beam having a channel riveted to the bottom flange. These beams are of 10½-ft. span, seated on the end walls and a middle pier in the inclined side of the pit. Firebrick casing protects the steel beams and the upper part of the wall from the hot cinders.

Washing Platform—A special feature is a concrete platform on which the incoming engines are washed down with a spray of oil and hot water and a final jet of hot water from hose pipes. This is a modern arrangement, now being introduced extensively at large terminals in order to reduce the tedious, costly and dirty work of cleaning and hostling engines by hand. The platform, extending over the two inbound tracks, is 100x41 ft., and 6 in. thick. The surface is sloped in drainage planes to deep drains along the middle and at each side, connected by cross-drains 14 ft. 3 in. apart, these latter being covered by plank floors. The drains lead into the terminal sewer system which discharges into the river through a city trunk sewer.

Turntable—The turntable, 110 ft. long and designed to carry engines and tenders with a total weight of 450 tons, is of the twin-span type, which has end and center bearings, so that engines do not need to balance on the table but can be turned as soon as the wheels are clear of the fixed tracks. The pit is floored with concrete and has

a concrete wall with a bench on which are heavy base plates carrying the 130-lb. circle rail for the electric tractor and the truck wheels of the turntable. This rail is secured by clips to long anchor bolts.

A steel curb around the top of the pit wall consists of an 8-in. H-beam bent to shape and secured to the wall by anchor bolts. Upon it are ¾-in. base plates carrying the ends of the track rails. Against the back of the H-beam, and also seated on the pit wall, is a ring of 7x9-in. ties, with tie plates for the rails.

Roundhouse—This is a timber frame structure with brick walls and concrete foundations, and is notable in having its roof timbers creosoted. It is in two segmental

Track doorways 16 ft. 10 in. high and 14 ft. clear width are separated only by the cast-iron posts of the inner wall, carrying the wooden swing doors. The interior headroom is 20 ft. at the girder spans and 23 ft. 9 in. under the trusses. There is no monitor or skylight, but the rear walls have large windows of wire glass in steel sash; there is also clear glass in wood sash above the doors and in the upper panel of each door. The floor is of concrete, a 6-in. slab laid on an 8-in. bed of cinders.

No outside inspection pits are provided, but all inspection and repair of engines are made in the roundhouse. The shop is equipped with a boiler washout plant which is supplemented by a recently perfected direct-steaming

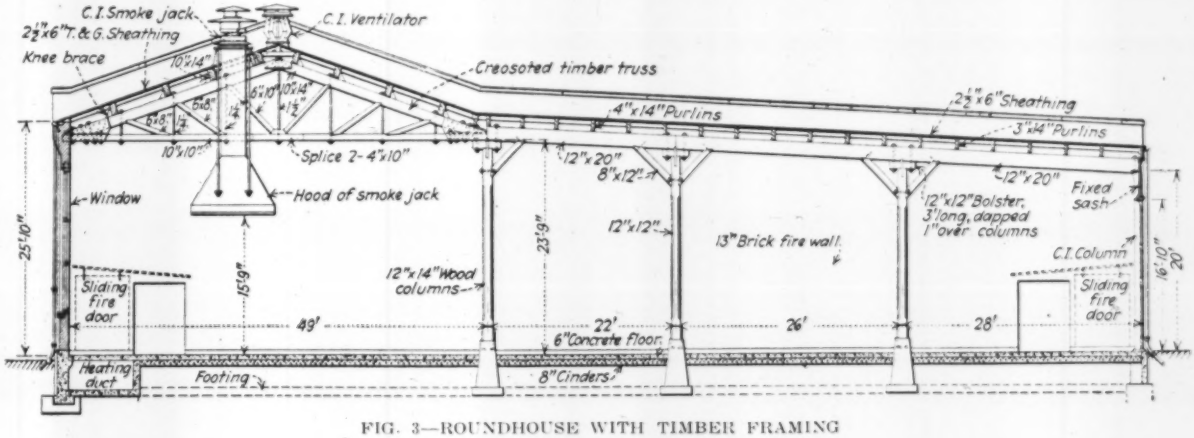


FIG. 3—ROUNDHOUSE WITH TIMBER FRAMING

parts for twenty and nine stalls respectively, and between them is the enginehouse lead to the west end of the yard, as shown in Fig. 2. The smaller structure may be extended to include 25 stalls, giving total accommodation for 45 engines. Transverse fire walls divide the buildings into sections having seven to nine tracks. The building is 125 ft. wide and its inner wall has a radius of 120 ft., giving a clear open space of 50 ft. between the wall and the turntable. The house tracks diverge at angles of 6 deg. 40 min., but some of the leads have angles of 10 to 13 deg.

For the roof framing, Fig. 3, three rows of timber posts and the side walls carry three 22- to 28-ft. spans of radial roof girders and a 49-ft. timber truss span. This truss span is at the outer side of the building. Timber purlins resting on these girders and trusses support the roof sheathing of 2½x6-in. plank, covered with composition roofing. Ventilators are placed along the ridge of the truss span. Over the end of each track pit is a cast-iron hood 4x10 ft., tapering up to a 36-in. cast-iron smoke jack in the roof. These hoods are suspended from the roof framing. Fir is used for the posts, purlins, girders and truss timbers; other structural timbers are of yellow pine. All roof timbers were creosoted before erection. The use of creosoted timber for the frame work of enginehouses is becoming more prevalent due to the difficulty of protecting steel against attacks by gases.

device, by means of which the boilers of the locomotives are filled with hot water and then high-pressure steam from the power plant is used to raise steam pressure in the locomotive boiler sufficiently to enable the engine to be run out of the house before the fire is lighted under the boiler.

Engine Pits—In each stall the pit is 3 ft. 7½ in. wide and 95 ft. long, with sump and grating for sewer connection at the inner end, as shown in Fig. 4. The bottom is convex, with a radius of 5 ft. 9 in., and has 8 in. of cinders covered with 4 in. of concrete on which is a ½-in. sand cushion for paving brick grouted with cement. Angle irons protect the edges of the concrete walls. Rails of 90-lb. A.S.C.E. section are laid on ¾-in. base plates and secured by clips to anchor bolts in the pit walls. The concrete floor of the enginehouse is laid against the rails, but a ½-in. depression 4-in. wide is formed outside the rail

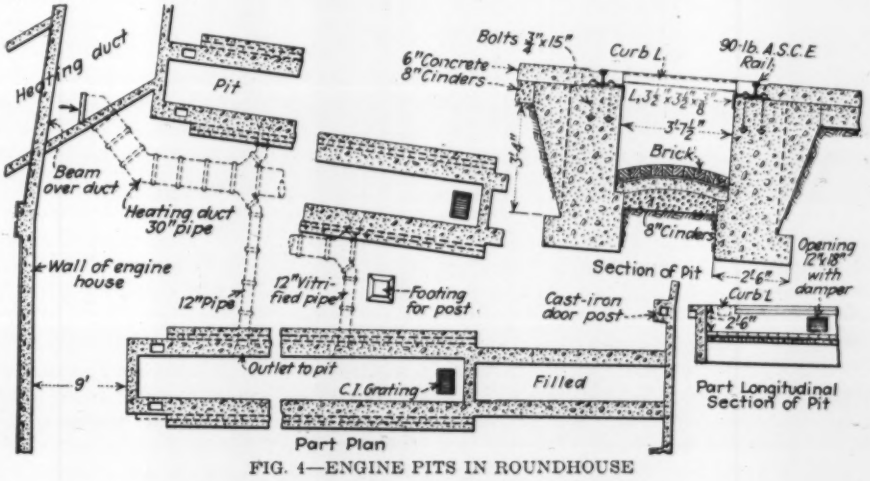


FIG. 4—ENGINE PITS IN ROUNDHOUSE

heads so as to clear the false flanges of worn wheels. Beyond the pits the walls continue to the inner side of the building so as to support the rails, but the space between them is filled and then covered with the concrete floor.

Two pairs of pits have transverse drop pits for removing and replacing engine wheels. These pits, Fig. 5, are 7½ ft. wide and 7 ft. 4 in. deep, the bottom having a track of 80-lb. rails. One pit is equipped with a 25-ton, the other with a 50-ton electrically operated drop table, for handling the removal and replacement of wheels and trucks under engines. The drop pits are covered with 3x6-in. oak planks when not in use.

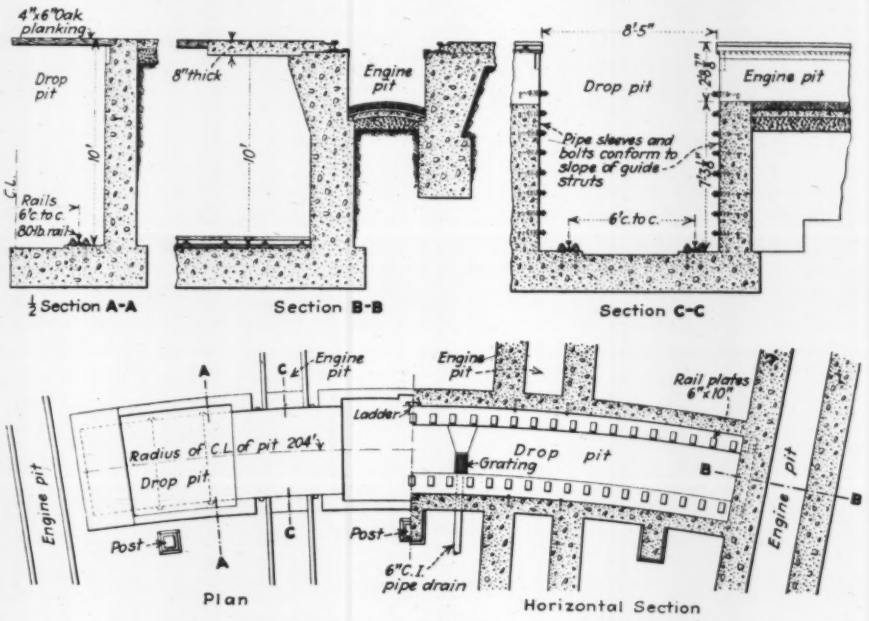


FIG. 5—DROP PITS FOR REMOVING ENGINE WHEELS

A concrete heating tunnel extending around the outer wall of the house is connected with the fan room of the heating plant and has a branch for each pair of pits. These branches, reducing from 30-in. to 20-in. vitrified pipe, have 12-in. laterals opening into the pits, the 12x18-in. outlets being fitted with gratings and dampers. Where the through lead track crosses the tunnel each rail is carried by a 15-in. H-beam, the bottom flange of which is level with the inside of the tunnel, while the top of the 8-in. concrete roof is carried up to inclose the beam. Foundation walls adjacent to the tunnel were covered below the grade line by two coats of waterproofing composition as a protection against moisture.

Repair Shop and Storeroom—Adjacent to the roundhouse are two buildings containing the engine repair facilities or backshop, locker rooms and storeroom. Toilet, locker and washroom facilities for both white and colored employees are provided in a building occupying the space between the mill room and the angle of the roundhouse. These rooms have unplastered brick walls and concrete floors with curb 6 in. high, so that cleaning will not affect the partitions.

The repair shop, 136x86 ft., is of steel frame construction, with I-beam columns supporting shallow roof trusses of 63 ft. 2 in. clear span. Along one side is a 19-ft. extension with I-beam roof girders. In the main portion every third bay of the roof is 6 ft. below the tops of the trusses, the higher sides forming monitors and being fitted with hinged steel sash. The roof has 8-in. channel purlins with nailing strips bolted on top for the wood sheathing.

Wood-block paving on a 6-in. concrete base is used in the machine shop, mill room and wheel shop; the blacksmith shop has a cinder floor, whereas the tool room, air-brake testing room and toilet rooms have 6-in. concrete floors. In the roofs of the machine and blacksmith shops there are 18-in. ventilators.

The storeroom and office building is a two-story reinforced-concrete structure 130x51 ft., with brick curtain walls and wood-sash windows and having a basement under the storeroom. Outside is a 10-ft. concrete platform at the first-floor level, 3 ft. 9 in. above the track, approached by a ramp. The truck entrance has a short ramp to an inside platform 1 ft. above ground level, from which one ramp slopes at 2¾ in. per foot down to the basement and another at 1½ in. per foot up to the first floor. On this floor are rooms for the enginehouse foreman and engine dispatcher; the second floor has the car foreman's office, medical examination and eye-testing room, and a rest room for the enginemen.

Heating and Light—A brick building houses the heating plant, including a boiler room, engine room and fan room, with annex for the hot-water tanks serving the boiler washout system already mentioned. The fan delivers hot air for heating the enginehouse, its outlet conduit leading to a chamber 8 ft. high and 9 ft. wide, from which a tunnel extends around the enginehouse. Coal for the power plant is delivered on a track alongside the building, dumped into a pit, hoisted into a 50-ton storage bin and by means of an electrically operated skip running on an overhead larry track is delivered to the stoker hoppers of each of the five 150-hp. boilers. Current for electric light and power is purchased from a local company. For lighting the roundhouse there are lamps of 100 cp. spaced six to each stall and suspended from the roof framing.

Builders and Engineers—The general contractor on grading was the Walsh Construction Company, Davenport, Ia.; the Austin Company, Cleveland, Ohio, built the enginehouse and other terminal buildings, and the Ogle Construction Company, Chicago, built the coaling station. Tracklaying was done by railway forces. This new engine terminal was designed and built under the direction of Hadley Baldwin, chief engineer, and W. S. Burnett, chief engineer of construction, Cleveland, Cincinnati, Chicago & St. Louis Railway.

Chicago Plans 1933 Exhibition

It has been proposed to hold a large exhibition at Chicago in 1933, and a local commission has been appointed to consider tentative plans. A board of architects also has been appointed, with Edward H. Bennett as consulting architect to design a general plan for the exhibition.

FIG. 1—ARTIST'S DRAWING OF MOUNT HOPE BRIDGE IN RHODE ISLAND

Design of Mount Hope Wire-Cable Suspension Bridge

Toll Structure With 1,200-Ft. Suspended Span Displaces Highway Ferry Between Providence and Newport, R. I.—Cable-Bent Piers and Offshore Anchorage Necessary—Silicon Steel Truss Chords

CONSTRUCTION work has recently begun on a wire-cable suspension bridge across Mount Hope Bay in Rhode Island. With a 1,200-ft. main suspended span, 504-ft. suspended side spans and steel viaduct approaches totaling 2,802 ft., the structure is 5,010 ft. long. When completed, it will form the connecting link (now furnished by a ferry) between Providence, on the mainland, and the important summer colony of Newport. The bridge is being constructed by private intrests as a toll project.

Mount Hope Bay lies north and east of Narragansett Bay, the two being connected by a short strait about 2,500 ft. wide. It is across this water that the bridge is being constructed between the towns of Bristol and Portsmouth (Fig. 2).

Plans for a highway crossing at this location as a state project were introduced in the Legislature in 1926. In March, 1926, a state commission reported that traffic warranted a toll bridge, and recommended a 1,200-ft. cantilever structure to cost $6,000,000. Authorization of a state bond issue for this amount failed because of the necessity at the moment for passing other large public improvement bond issues. Private interests immediately took up the project, and in April, 1927, received permission from the Legislature to construct a bridge privided it be completed by 1931. The present structure is the result.

Its cost is financed by $2,850,000 of 6½ per cent first mortgage bonds, $1,300,000 of 25-year sinking fund 7 per cent debenture bonds, $100,000 of 7 per cent cumulative preferred stock and 50,000 shares of no-par value common stock. The sale of the securities was handled by a syndicate of New York investment bankers, while the securities are guaranteed by Pittsburgh financial interests allied with the contractors. The contract stipulates a completion date of July 1, 1929, with a penalty and bonus of $1,000 per day.

Site and Foundation Conditions—Both shores are comparatively flat, making rather long approaches necessary. The geological strata at the channel piers include fine sand, a mixture of clay, gravel and boulders, and shale. All piers are founded in the clay and gravel strata, because of the depth of the shale, 83 ft. below mean low water at the north main pier, and 56 ft. at the south main pier. The clay and gravel is very stiff and compact, containing in considerable quantity boulders ranging from 3 to 10 in., and some much larger. Its compactness is illustrated by the fact that core drilling was necessary when making the borings. The foun-

FIG. 2—MOUNT HOPE BRIDGE LOCATION

dation will be 55 to 60 ft. deep for the Bristol main pier and about 38 ft. deep for the Portsmouth main pier, while the anchorages and cable-bent pier foundations range from 15 to 20 ft. below datum. At the present time work is under way on both anchorages and the approach pedestal piers, while both cofferdams for the main tower piers have been launched and dredging is proceeding for their foundations.

General Design—A desire to limit the main span to 1,200 ft., for economy, and at the same time to locate the anchorages on land or as near shore as possible dictated the use of cable-bent piers and towers at the ends of the side spans. The main-span cable has a 120-ft. sag (1:10) and provides a 135-ft. channel clearance for a width of 400 ft.

The approaches on the north or Bristol end consist of a concrete road 980 ft. long, and 1,096 ft. of steel viaduct of cantilever construction with 60-ft. suspended spans in alternate 100-ft. spans. On the Portsmouth end the steel viaduct is 1,706 ft. long and the concrete road 130 ft. On the approaches a 30-ft. roadway is provided, while on the main spans and viaduct there is a 27-ft. clearance between the sidewalk curbs. The bridge roadway is a 7-in. reinforced-concrete slab on stringers, which in turn rest on floorbeams framing into the stiffening trusses about midway between the upper and lower chords. The sidewalks are 2½ ft. wide, of precast concrete slabs, covering the space provided for pipes and conduits.

The assumed loading for the floor system was three lines of 20-ton trucks spaced 33 ft. centers plus 30 to 37 per cent impact, and for the trusses and girder spans three lines of 15-ton trucks spaced 33 ft. centers with allowance for impact on the girders.

Towers—The structural steel towers are 284 ft. high above mean low water. Their elevations as seen from the ends of the bridge are unusual, due to the arrangement of the bracing to form a high pointed arch over the roadway. Each tower post is cellular, with eight compartments, lacing being used on the up- and downstream faces. The towers are of the fixed-base flexible type. The base casting is made in four parts to be bolted together, designed for filling with concrete.

Anchorages—The anchorages are of concrete with sand-filled chambers. Nothing unusual appears in their construction except for the fact that one of them is located off shore. Inside of each anchorage, the wire cable splays into seven groups of eyebars, two eyebars in each group. This chain anchorage, which is 80 ft. long, terminates in three sets of box girders solidly concreted into the anchorage.

Cables of Heat-Treated Wire—There are to be two 11-in. wire cables, 34 ft. apart, each consisting of seven strands of 350 wires (No. 6 galvanized, diameter 0.196 in.), or a total of 2,450 wires per cable, providing a total cable cross-section of 74 sq.in.

For the first time in suspension bridge history heat-treated wire is being used. While but little superior in ultimate strength to untreated wire, it will have a yield point of about 85 per cent of the ultimate, in place of the usual 65 per cent (190,000 lb. instead of 144,000 lb. per sq.in.).

Each suspender consists of four parts of 1⅜-in. steel-wire rope, two ropes being looped over each cable band. Suspender attachments to the stiffening trusses are by sockets installed in reinforcing angles on the outside of the top chords. One-inch galvanized steel wire is used for hand rope.

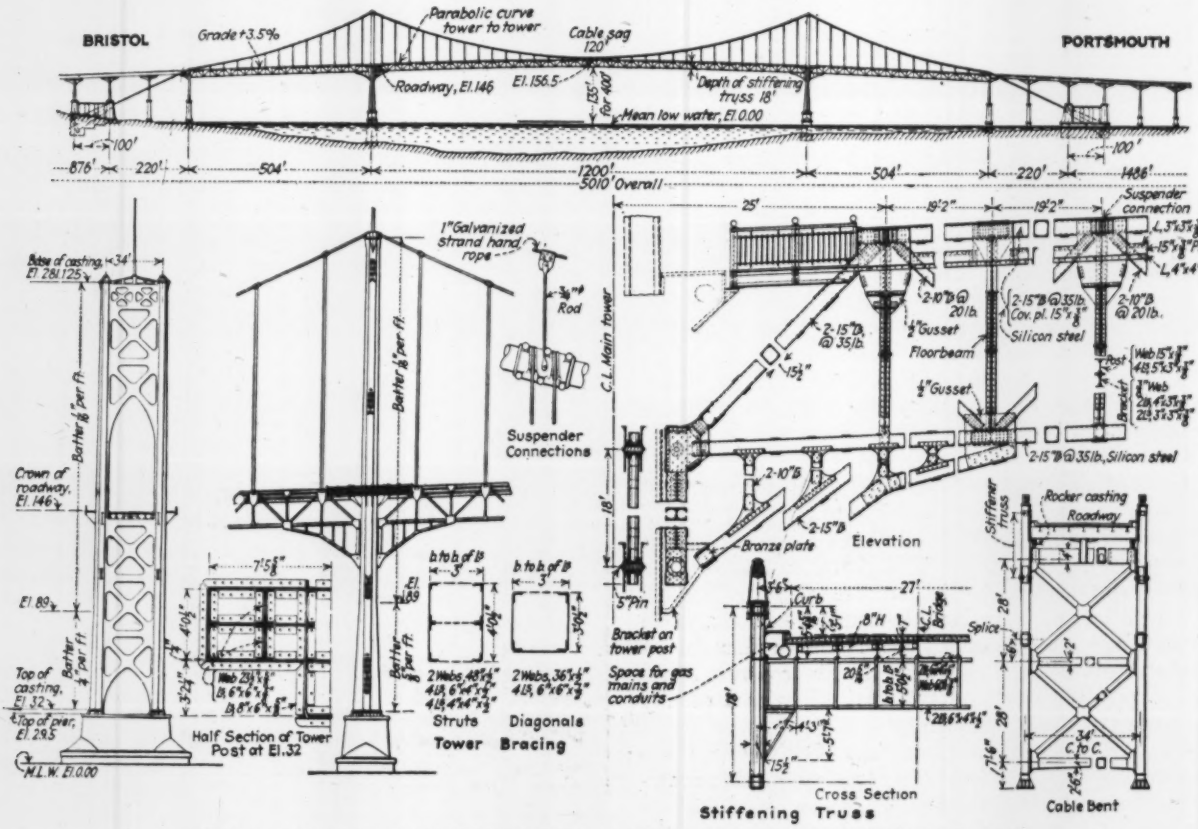


FIG. 3—STRUCTURAL FEATURES OF 1,200-FT. WIRE-CABLE SUSPENSION BRIDGE ACROSS MOUNT HOPE BAY, RHODE ISLAND

Stiffening Trusses—The stiffening trusses are 18 ft. deep and discontinuous at the towers. Both the upper and lower chords are of silicon steel, used with working stresses of 34,000 lb. per sq.in. tension and 28,000 lb. per sq.in. compression. With the exception of the special steels, such as pin steel, eyebar steel and rivet steel, all other steel is medium carbon, the working stresses for which are 26,000 lb. tension and a maximum of 21,000 per sq.in. compression. Expansion in the stiffening trusses is provided for by rocker connections on the towers.

Floorbeam panels are 19 ft. 2 in. Floorbeams 60 in. deep supply the lateral bracing, aided by knee braces extending to within 2 ft. of the bottom of the stiffening trusses. Longitudinal windbracing is provided in the plane of the top of the floorbeams. The splices in the chords of the stiffening trusses are arranged so that the trusses will be erected in two-panel units, the bottom-chord splice being placed at the intersection of the diagonals with the bottom-chord and the upper-chord splice being placed at the chord intersection with the single vertical compression member.

The owner of the bridge is the Mount Hope Bridge Company, C. P. Coleman, president. Robinson & Steinman, consulting engineers, New York City, are in charge of the design and construction. The contract was let to the McClintic-Marshall Company, Pittsburgh, which has sublet the substructure to the Foundation Company (work now under way); the cables to the Keystone State Corporation, Pittsburgh; the cable material to the American Cable Company, New York City; the bridge roadway to the Hughes-Foulkrod Company, Philadelphia; the Bristol approach to the Callan Construction Company, Bristol, R. I.; the Portsmouth approach to Westcott & Munroe, North Attleboro, Mass.; and the electrical installation to Scannevin & Potter, Newport, R. I.

Co-operation Sought to Relieve Traffic Congestion

Co-operation of city planning authorities and municipal, county and state officials with motor clubs in launching a nation-wide campaign for wider highways and for the separation of grade crossings was urged in resolutions passed by the Motor Congress of the American Automobile Association in its recent meeting in Washington. In presenting the resolutions it was pointed out that the congestion in urban areas is already depriving hundreds of thousands of people of their only recreation, the use of automobiles on Sundays and holidays.

This growing congestion, it was contended, is not only a potent factor in the mounting toll of accidents but threatens the development of the automobile as a means of transportation. Further discussion developed that the nation as a whole is not giving the problem of city planning, from the traffic standpoint, sufficient attention.

Ancient Chinese Method Used to Close Levee Breaks

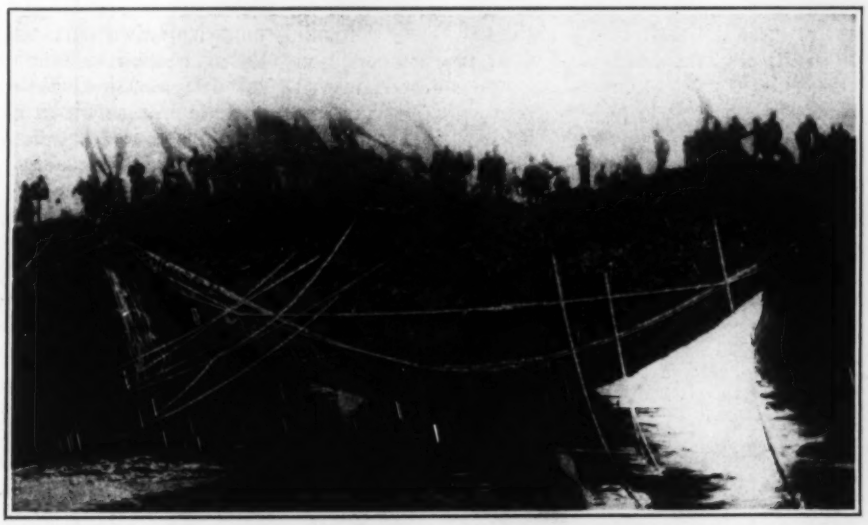
Kaoliang and Clay Plugs Wound With Bamboo Rope Thrown Into Breaches on Yellow River Dikes

By O. J. Todd
Chief Engineer, China International Famine Relief Commission

THE Chinese have an ancient but striking method of closing breaks in river levees. The accompanying illustration shows a built-up plug of kaoliang (tall millet) stalks and earth, held in place by ropes and netting, being lowered into a dike breach on the Li Shun Tun Yellow River dike.

Kaoliang stalks are similar to our American corn stalks and are about 10 to 12 ft. long, including roots, which are left on for this work. In closing a gap piers are built out from both ends of the opening, using these kaoliang stalks with root ends always out, making the piers about 20 ft. wide. On each layer of kaoliang compressed to a thickness of 6 in. is placed an equal layer of earth. Alternating layers of kaoliang and earth are then placed to the top.

When the gap has been made as narrow as possible by this means due to the rush of escaping water, a number of 2-in. to 4-in. bamboo or hemp ropes are placed across the gap lying parallel and about a foot apart. These are sometimes woven together by a netting as shown in the illustration. On this hammock the plug is built while scores of men hold the ends of the ropes on the two piers. As the plug grows it is gradually lowered to the water. Guy ropes hold it from being swept downstream as it is being finally dropped into place. At once hundreds of men rush onto the plug with baskets of earth and more kaoliang to build it up to the necessary height and make the closure water tight. When the depth of water flowing through the gap is only a few feet, this system works admirably. But in the history of the Yellow River many such plugs have failed to stick long enough to be properly weighted due to the strong current of the flow through the gap and the depth relative to the height of the plug. This method is successful, however, after the flood has subsided.



PLUG OF KAOLIANG AND EARTH BEING LOWERED INTO A LEVEE BREAK

"KNOW YOUR IMHOFF TANKS"

But Choose Warm Weather and Wear a Diving Suit

By Morris M. Cohn
Sanitary and Testing Engineer, Department of Public Works, Schenectady, N. Y.

THE poets have long extolled the heroism of those men of science who have exposed themselves to great dangers and suffered physical hardships, all for the sake of amassing information that would lighten the burdens of mankind. None has sung the praises of the sewage-works operator who has suffered the slime of sludge and scum to extract truths that would lighten the gloom of others of his calling and make their lives more livable. If poets chose as background the babbling sewage that wends its way unceasingly through tanks and filters to the sea, the lyre would be strung and the welkins would ring with tales of unselfish suffering by those sanitarians who are attempting to hasten the limpid waters on their way.

Previous to the early days of 1928 I had inspected the interiors of many empty settling tanks, examined the details of construction of the nice gray concrete and shiny black piping fittings, and speculated on the per capita capacities of sludge and scum compartments. How many times during tank operation have I attempted to probe the extent of scum blanket or determine the elusive level of sludge in the mysterious depths of storage hoppers? How many times have I massaged the sloping walls of sedimentation compartments with a squeegee and clanked a heavy chain along the slots? Just often enough to wish that I had an X-ray eye or possessed a periscope attachment that would enable me to see the tanks in action. Yes, often enough to wish that I had arms as long as a pitcher-pump suction hose or a sounding-plate chain so that I could feel what the tanks were doing.

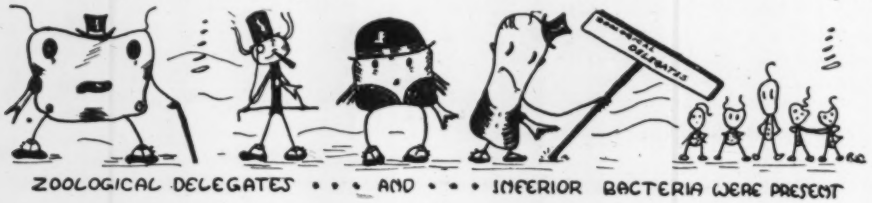
I felt that way previous to the early days of this year. I know now that you do not need X-ray eyes or elongated arms to know all and see all. Actuated by the recognition of the utter helplessness of visualizing the condition of the tanks intrusted to my tender care and overpowered by a burning desire to glean information that could be used to alleviate the gnawing scientific curiosity of other operators, I made an excursion down into one of my tanks in operation. My investigation prompts me to say that you don't know your Imhoff tanks until you have been into them at least once.

My decision to carry on this survey came rather suddenly. In fact, I had been attempting to shovel scum into a sludge-pipe riser but a short moment before, and I am willing to admit that my decision was made in the air between the narrow crosswalk and the inviting sewage in the sedimentation compartment. The freeboard of the tank being but a scant half-foot, a quick decision was imperative. I took my shovel with me. I would have gone down into the sludge compartment and carried on my study there, but that did not happen to lie in the path of my trajectory, so I decided on the sedimentation compartment research. To prove that I was willing to gain information at any cost, let me offer the facts that I chose a cold day and the inlet end of the tank for my investigation. I could have picked a time when I was sterilizing the tank by prechlorinating the crude sewage, but I wished to view the biological what-are-theys in their natural state.

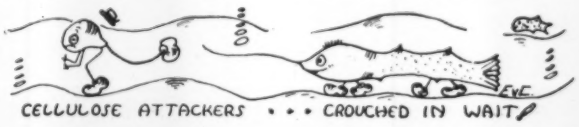
My inspection made clear to me the secrets of tank operation, dimmed only by the slight turbid opalescence of the tank liquid. Nitrogen cycles were spinning

around about me like so many pinwheels, with their nitrate tails sticking in their ammonia mouths. Supercilious chloride radicles sailed majestically toward the effluent end of the tank, safe in the realization that the fauna would allow their passage unhampered, because their salty taste did not appeal to the faunal appetite. Dignified little pH's floated by, deep in their hydrogen-ion concentration. My tank bacteria workers were busy earning their keep. Lactose fermenters, sulphide producers, nitrate reducers, cellulose attackers and albumin digesters—the entire phalanx crouched in wait for choice morsels of their particular liking to come popping out of the inlet pipe into their happy hunting ground. Zoölogical delegates jostled through the throngs of inferior bacteria like so many big brothers of the underworld. The ciliates and flagellates with the silly shapes and the unpronounceable names looked for new worlds to conquer. I was impressed with the generosity of the animals and organisms privileged to live in the upper strata of fauna society in passing food down through the slots to their less fortunate brethren who inhabit the regions below and out over the effluent weir to their cousins who have their homes in the filters.

For the sake of sweet science, I swallowed some 50 c.c. of sewage containing upward of 50,000,000 bacteria of unclassified types. If the stuff affects my happy family of tank workers as it did me, I am sold on the idea of my tank liming as a means of preventing heartburn suf-



fering by the poor tykes. I will raise the status of the lowly pH's to the optimum plane that they deserve. I had often bewailed the fact that the solids deposited in my tanks rose to the tops of the gas vents in the form of scum, and had attempted by beating them with paddle and water stream to inveigle them into lying down in



the deep dungeon of the sludge hoppers. Now that I have been down into a tank, I cannot but sympathize with them in their desire to rise again to view the sunlight of another day. I know now that the haste of the solids, that have been cooped up in the tanks all winter, to greet the fragrance of the springtime is the only thing that causes foaming. It strikes me as altogether a sensible thing for them to do. Far be it from me to attempt again to force scum down through a sludge pipe riser into the uninviting depths below.

Although I entered the tank in the interests of science, there are certain experimental costs which I should not be compelled to shoulder. In my haste to carry out the study I forgot to prepare for my immersion and as a result an overcoat, a suit, a hat and a pair of shoes required dry cleaning and disinfecting, not to mention other articles of apparel damaged. I am writing this article in the hope that its publication by *Engineering News-Record* will encourage other studies of this nature—and will defray the cost of my investigation. Now that the pioneer work has been carried out, it would be best that other operators study the workings of their tanks during the warm months. The cost of the study will be markedly lower and reconnoitering about the tank bottom will be easier without a heavy overcoat. If a nation-wide association of sewage-works operators is ever organized, it is recommended that membership be limited to those who know their Imhoff tanks.

Long Service Tests of Thin Steel Show Varying Life

Steel Flumes, Pipes and Shells of Bridge Piers Examined After Long Service—One Pipe in Ground 58 Years

In the Three Notes following, all related to the life of thin steel plates or pipe in service, two report a very long period of service with the metal still in excellent condition, whereas the third, by contrast, is a case of short life due to corrosion. These three items are grouped to encourage comparison and conclusions. The most significant of the three is the case of the thin water pipe taken up 58 years after laying and found still worth reconditioning for further service. This instance puts great emphasis on the importance of securing a protective coating that is effective and durable. —Editor.

* * * *

Water Pipe 58 Years in the Ground Is Still Serviceable

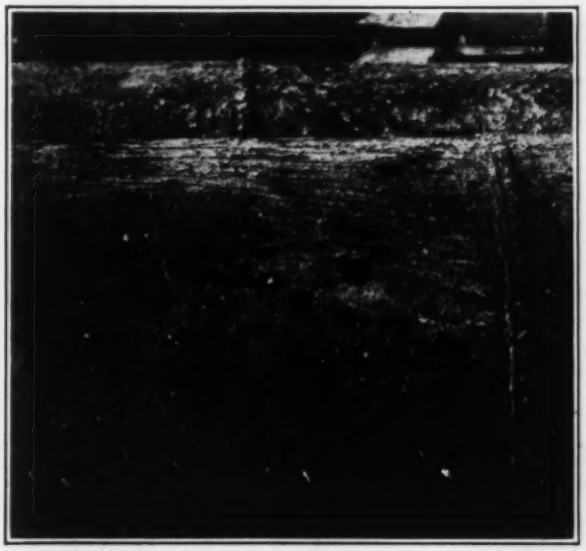
THE Spring Valley Water Company, which serves the city of San Francisco, has recently taken up a 30-in. riveted water main that has been in the ground 58 years. After cleaning up the 30-ft. sections of this pipe they were found to be still in servicable condition and in all probability most of them will receive a new protective coating and be again put in service.

The main, known as the San Andres pipe line, was put in service in 1870, buried in a sandy, yellow clay, working under a pressure of 55 lb. per sq.in. The plates from which the pipe was made are wrought iron, $\frac{1}{8}$ in. thick, and since they do not conform to any gage, they must have been specially rolled to this thickness. The protective coating on the pipe was that usually applied by the company at that time and consisted of natural asphalt mixed with varying amounts of coal tar.

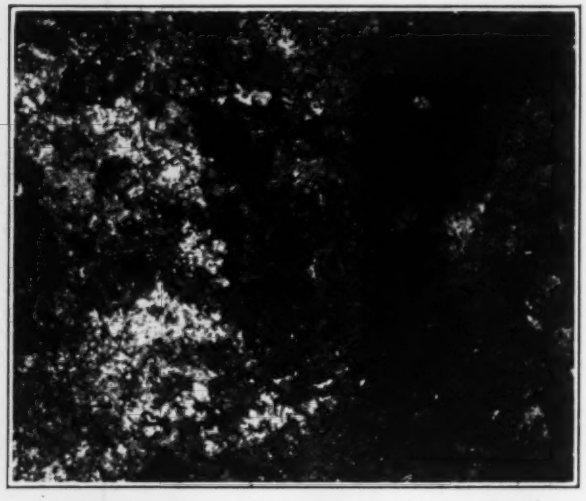
The main was in service continuously from 1870 to 1922, when about 3,000 ft. of it was replaced by a new line made necessary chiefly because the old line had been built before the streets were laid out. Also two short portions of the line close to a street railway substation had been damaged by electrolysis in the absence of any provision for mitigating electrolytic effect. Since 1922 the pipe has been out of service, but was left in the ground until street grading necessitated its removal.

To make careful examination of its present condition several lengths of the pipe were brought to the yard and the adhering earth was washed off, care being taken, both in handling and in cleaning, to keep the coating from coming off the pipes. Despite these precautions some of the coating was jarred loose, but the condition of the metal in the bare spots showed that the coating had come off with the adhering clay and had not been previously loosened.

The outside surface of the pipe was in almost perfect condition. The inside was tuberculated over its entire area, the tubercles being mostly about $\frac{1}{2}$ in. high, with some rising to the height of 1 in. After cleaning these tubercles from the inner surface, large shallow pits were found, ranging from $\frac{1}{64}$ to $\frac{3}{64}$ in. in depth. None of these pits extended as much as half way through the pipe



WATER PIPES THAT WERE IN THE GROUND 58 YEARS
Protective coating was applied by dipping and the longitudinal ridges made as the coating drained off after dipping are still visible near the top of the pipe section.



INSIDE SURFACE OF PIPE IN SERVICE 58 YEARS

thickness, and on the whole the metal was in such good condition that it was considered worth while to clean the pipe sections thoroughly and give them another protective coating preparatory to further service.

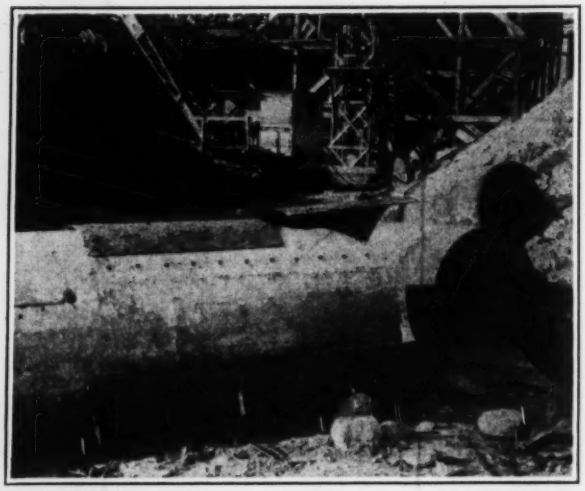
For the foregoing information, *Engineering News-Record* is indebted to George W. Pracy, engineer of distribution, Spring Valley Water Company.

* * * *

Steel Shells in Service 39 Years Still Sound and Serviceable

IN THE RECENT reconstruction of the First St. viaduct in Los Angeles it has been necessary to remove piers under the old structure that have been in service since 1889. Each of these piers consisted of two concrete cylinders 4 ft. in diameter, cast in cylindrical shells made up of ¼-in. steel plates. Since it was necessary to remove the old piers entirely, opportunity was afforded for examining the metal of the cylindrical shells.

Of the total 49-ft. length of each cylinder, about 11 ft. had been below ground-water level, 30 ft. had been surrounded by dry sand and gravel, part of which was occasionally wet when water flowed in the Los Angeles River,



STEEL PLATES ON BRIDGE PIERS IN SERVICE 39 YEARS
These plates, all in good condition, were removed by cutting out the rivets and spreading the shells.

and the remaining 8 ft. was above ground level. Below water level the outside of the steel shell showed some pit marks that had a maximum depth of about $\frac{1}{16}$ in. The portion above ground-water level showed slightly more pitting on the outside, but the average depth here was only about $\frac{1}{16}$ in. Above the ground, where the outer surface had been kept painted, there was no evidence whatever of deterioration, the steel being apparently in quite as good condition as when it was put in place. The inside face of the steel shell for its entire length was as clean and as free from corrosion as the day it was placed. There is no record of any protective coating on this inside face and since no indications of any coating appear, it is believed that none was applied.

For the foregoing information *Engineering News-Record* is indebted to Merrill Butler, engineer of bridges and structures, department of engineering, Los Angeles, Calif.

* * * *

Corrosion of Metal in Pipes and Flumes in Imperial Valley

EXPERIENCE with metal pipes and flumes used by the Imperial Irrigation District has indicated that they are subject to some corrosive action of a chemical or galvanic nature that materially shortens the life of the metal. That the cause of this corrosion is in the water and not in the surrounding soil is indicated by the fact that flumes suspended in air show action quite the same as that on pipes buried in the ground. Because the action is more rapid in the lower part of the wetted perimeters, it is suggested that there may be some relation between corrosion and the heavy silt content. Another possible explanation is the high oxygen content found in water used in Imperial Valley.

A flume about 4 ft. wide made of 14-gage metal and suspended above ground had to be replaced after three years of service because of holes corroded entirely through the metal. The corrosion was most pronounced at points where metal bands passed around the flume and at joints where a slight irregularity on the bottom was caused by the crimping of the metal plate to receive the compression band that made the joint.

In the case of large pipes the corrosion is much the same. A 6-ft. pipe buried 20 ft. below the surface of the ground recently collapsed in service after being in the ground nine years. When this pipe was removed its lower part was found to contain many holes entirely through the metal that had been the cause of the collapse.

Nutshells Supersede Shavings on Hog Farm

Walnut shells ground finely enough to pass through a $\frac{1}{16}$-in. screen and which are a byproduct from nut-packing plants have been substituted for shavings as bedding at the Fontana hog farm. At that farm Los Angeles garbage is used for hog feed and waste cleaned up from the pens is made into fertilizer. Shavings, particularly when made of redwood, are more or less objectionable in the fertilizer and add nothing to its value chemically. Ground walnut shells, on the other hand, are not at all objectionable and add a slight percentage of desirable chemical element. The nutshells, costing $3 per ton f.o.b. packing plant, are somewhat cheaper than the shavings and in addition can be handled and stored more easily.

Blade Grader Finishes Asphalt Road Surface

Rock Asphalt Laid on Penetration Leveling Course Over Old Concrete, Smoothed With Blade Grader After First Rolling

By W. G. Dickey
Construction Engineer, Stone Construction Company, Richmond, Ind.

UNUSUAL methods were employed last year in finishing rock-asphalt resurfacing on a badly broken-up concrete pavement on the state road north and south of Alexandria, Ind. The resurfacing consisted of a bituminous macadam leveling course and a top course of Kentucky rock asphalt laid cold. Before laying the intermediate, or leveling, course, stone shoulders were placed along the edges of the concrete, and earth shoulders were thrown up outside of them with a road grader. This work was done by the state maintenance forces.

As a preparation for the leveling course, the old concrete surface was thoroughly broomed and given a coat of cut-back asphalt, applied at the rate of 0.232 gal. per square yard on which No. 4 ($\frac{3}{4}$-in.) stone chips were spread to the amount of 9.53 lb. per square yard. The chips provided a key to prevent the larger stone in the intermediate course from creeping ahead of the roller.

The stone for the leveling course was applied with stone spreaders, followed by men with hand tools and templets to give the course a perfect crown. The crown in the original concrete was 2 in., and the new pavement was built with a 1½-in. crown. Stone was applied in the following proportions: No. 1 (4- to 2½-in.) size, 327.2 lb.; No. 3 (1½- to ¾-in.) size, 12.1 lb., and No. 4 ($\frac{7}{8}$- to ½-in.) size, 18.1 lb. per square yard. The large-stone course was rolled just enough to key the stone thoroughly. The hot asphalt was applied at the rate of 1 gal. per square yard and the course was again thoroughly rolled and allowed to cure for about a week. The No. 3 and No. 4 covering stone were then spread and rolled and given an application of $\frac{3}{10}$ gal. of liquid asphalt per square yard. The distributor spreading the second coat of penetration was immediately followed by two road rollers. This course was rolled for several days following the final application and was allowed to cure for a week before applying the rock-asphalt surface.

FIG. 1—LONGITUDINAL LUTING ON STEEL STRIP TEMPLETS

The rock asphalt was unloaded from railroad cars with a clamshell and hauled to the prepared base in trucks. There it was spread by shovels and the required crown and thickness of the loose material were secured by steel measuring strips and wooden lutes.

Triangular lutes were used to straight-edge the surface. These lutes ran on steel guides, Fig. 1, which were laid directly on the bituminous macadam base. As a final check, lutes were worked crosswise to take out any irregularities left by the lutes worked parallel to the roadway. This insured a nearly perfect surface before the first rolling with a tandem roller. After the asphalt had been rolled, a road maintainer, or a planer, Fig. 2, was run over it with the blades set to skim the surface. A truck load of asphalt moved along parallel with the planer and additional material was thrown in front of the planer blades to fill any depressions. This operation eliminated practically all irregularities not corrected during the spreading. A second rolling followed, and in turn this was followed by two more plannings and two more rollings. These gave the pavement a smooth, dense, uniformly compressed wearing surface.

The repeated planings and rollings are to be noted as a feature of the construction process which has much significance in working with a cold material like Kentucky rock asphalt.

The construction was carried out under A. H. Hinkle, superintendent of maintenance, Indiana State Highway Department, by the Stone Construction Company, contractor, of Richmond, Ind.

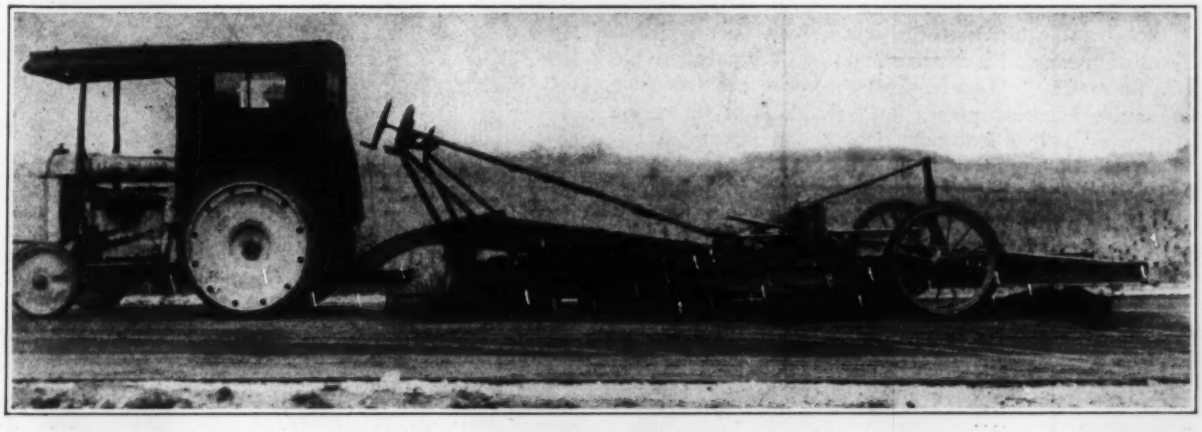


FIG. 2—PLANING ASPHALT SMOOTH WITH BLADE GRADER

Earth Moving in Mississippi Flood Control

Available Equipment Types and Capacities Appraised in the Light of the Volumes to Be Handled and the Available Sources of Levee Material

By George B. Massey
Vice-President, Randolph-Perkins Company,
Consulting Engineer, Chicago

THE plans for flood control in the lower Mississippi Valley require the major part of the money to be spent in handling earth. Specifically, $119,000,000 is allowed for spillways, dredging and revetting in one plan and $198,000,000 in another; there then remain

SMALL DRAGLINE CUTTING DOWN SPOIL BANK
This Diesel-driven dragline on a cross-state highway in Florida west of Tampa shows what would have to be done in cutting down the Cairo-New Madrid main levee.

$177,000,000 in one plan and $280,000,000 in the other for earthwork. As it is proposed to extend construction over a period of ten years, $18,000,000 or $28,000,000 will have to be expended each year for dirt moving. Assuming for convenience a price of 25c. per cubic yard, $18,000,000 means 72,000,000 cu.yd. and $28,000,000 means 112,000,000 cu.yd. of earth work per year, or say in round numbers from 3½ to 5½ times the amount handled heretofore per year by the M.R.C., as indicated by the accompanying table. Practically all of this work will be in latitudes admitting of year-around operation.

Character of Work to Be Done—The earth work to be performed includes: (1) Topping of old levees about 3 ft.; (2) reducing the height of levees; (3) relocating levees or building new levees, and (4) filling borrowpits.

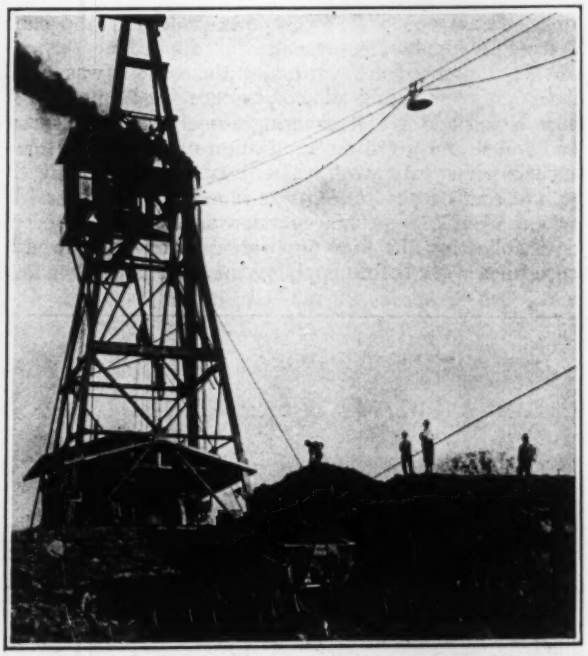
Most of the levees to be topped have borrowpits in front of them, and it is necessary to go beyond these old pits for material. This requires a tower or cable machine or double handling with a large dragline, or filling the borrowpit with a hydraulic dredge and digging it out again for the levee topping. Reducing levee heights can be done with small draglines and presents no difficulties. An alternative would be a shovel instead of a dragline. For new levees or relocated levees the earth can usually be obtained alongside, and the work can be done with large dragline machines and with one handling. The muck ditch, or exploration trench, can be dug with small draglines. New levees, if near enough to the river and the material is sand, can be built by pipe-line hydraulic dredges, using flashboards or not, as the situation warrants. If far away from the river, as in the floodways, large draglines will have to be used.

ANNUAL YARDAGE PLACED IN LEVEES BY M.R.C. FOR THE LAST FIVE YEARS

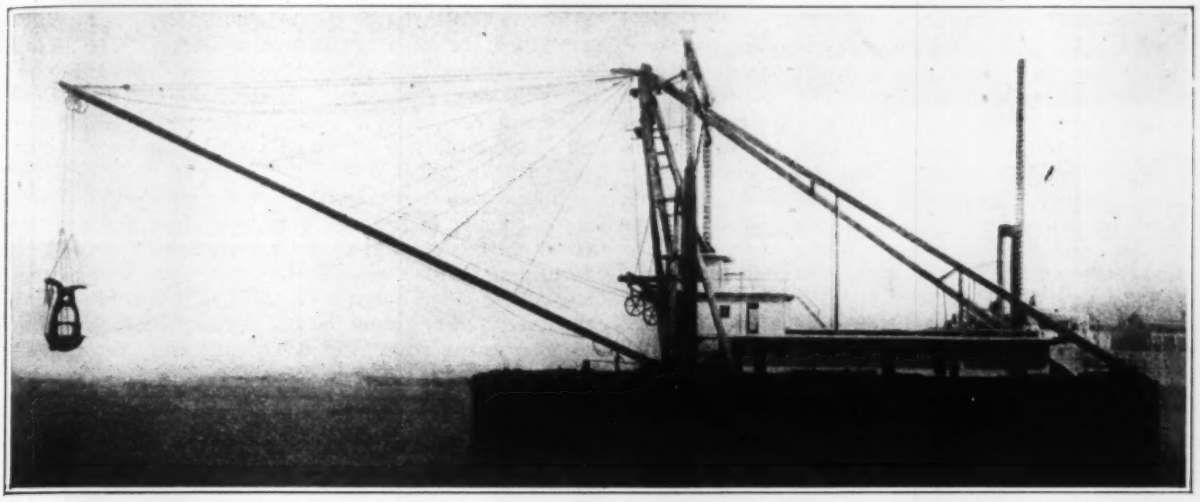
Year	Cu.Yd.	Total Cost	Cost Per Cu.Yd.
1923	19,670,829	$4,744,135	24c.
1924	17,690,703	3,902,796	22c.
1925	26,997,940	7,078,525	26c.
1926	22,995,681	5,572,681	24c.
1927	20,151,303	6,350,792	31½c.

Present Government Floating Plant—The last list of floating plant owned by the United States and employed in the engineer department is dated Dec. 31, 1922, and shows 25 sea-going hopper dredges, 71 hydraulic pipe-line dredges, 35 dipper dredges, seventeen clamshell or bucket dredges and six ladder dredges. Sea-going hopper dredges are not adapted to building levees, filling borrowpits, etc., as they can dredge only while moving slowly ahead and can dump only in deep water. Dipper dredges must lie too close to a levee to be able to build it and still keep it from sliding into the dredge or borrowpit. Another drawback is that a dipper dredge cannot leave traverses. Almost the same objections apply to the government clamshell and ladder dredges, all of which are small.

This leaves only the hydraulic pipe-line dredges which would be suitable for filling borrowpits and for building levees some distance from the river banks. Of the 71 pipe-line dredges, only 31 are located on the Mississippi River and its tributaries, three being on the Ohio, thir-



TOWER MACHINE TOPPING OUT A LEVEE
The M.R.C. has a dozen of these machines which operate over a span of 600 ft. with 5- and 6-yd. buckets. Probably the bulk of work for some time will be handled by this type of levee builder.

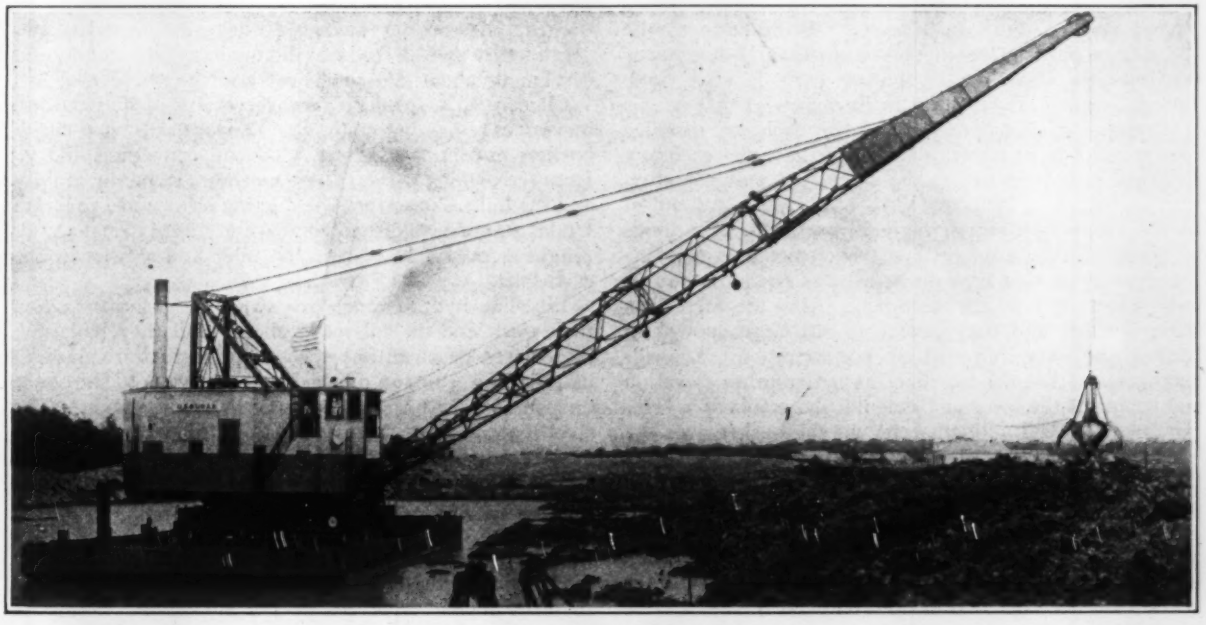


CALIFORNIA TYPE OF CLAMSHELL DREDGE
Dredge has 200-ft. boom and operates 5-yd. bucket.

teen on the upper Mississippi and fifteen on the lower Mississippi River. These dredges are of two general types: (1) Non-propelling dredges swinging on stern spuds while at work, and (2) self-propelling dredges, which put down hydraulic piles and then pull slowly up to these piles while dredging.

The self-propelling dredges have jet agitators in place of mechanical agitators and are used, with short pipe lines, to cut through bars in the river and discharge into the river at one side. The usual length of discharge pipe is less than 500 ft. Four of these dredges can pump through 1,000 ft. of discharge pipe with 5 ft. of static head, but must move forward while dredging. These dredges are used very little and are kept in reserve to cut through bars which form and obstruct navigation in low-water periods. For instance, each of the four dredges indicated averages only 55 days of ten hours for the entire twelve months. The last report of the M.R.C. states that during the year five channel dredges worked on twelve river crossings and moved 1,500,000 cu.yd. of sand. Eight channel dredges are reported as being available for this purpose. In other words, these are stand-by dredges which are vital to maintenance of navigation in the low-water period and are not available for general work.

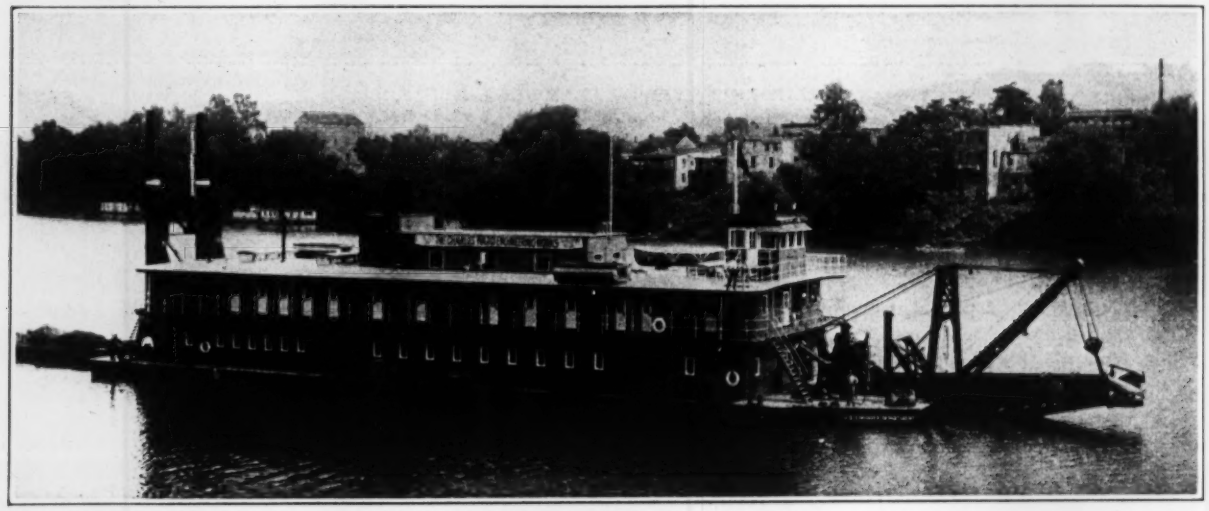
Of the non-propelling, pipe-line dredges, there are two with 28½-in. diameter discharge pipes and two with 32½-in. discharge pipes, all at St. Louis and all capable of handling 1,000 ft. of discharge. At West Memphis there is a 16-in. dredge, good for 3,000 or 4,000 ft. of pipe; a non-propelling dredge located here is powered for 1,000 ft. At New Orleans there is a 20-in. dredge, which will handle about 2,000 ft., and 20-in. and 24-in. dredges good for 1,000 ft.



ORANGE-PEEL MACHINE ON BARGE
The barge is 110 ft. long, 42 ft. wide and 7½ ft. deep, with a rake at one end. It has four 24x24-in. power spuds 34 ft. long. At 125-ft. radius the boom handles a 3½-yd. drag bucket, 3-yd. clamshell or 2½-yd. orange-peel.

Not more than half a dozen of the 31 pipe-line dredges on the Mississippi River and its tributaries are, therefore, suitable for levee building even if they could be spared for such work. It may be assumed that the 40 pipe-line dredges not on the Mississippi system are required for the purpose for which they have been built and maintained. The conclusion then is that pipe-line dredges for ten consecutive years of work must be those at present owned by contractors or new ones designed for the purpose.

Present Land Plant—The M.R.C., in addition to floating plant, owns and operates considerable land equipment, among which are eight large clamshell machines with 125-ft. booms and two with 155-ft. booms and 5-yd. clamshell or orange-peel buckets which can be used on land or can be run onto barges and used as floating machines. The commission also has a dozen or more draglines of smaller size, suitable for digging muck ditches and building small levees. In addition to the above-mentioned plant there are about a dozen tower machines or slack-line cableways with 5- and 6-yd. buckets, capable of operating with a span of 600 ft.



LARGE PIPE-LINE HYDRAULIC DREDGE
Cutter head type of suction is lifted above water.

Appraisal of Machine Types—The cableway machine consists of a head tower, a tail tower, a heavy cableway stretched taut from one to the other, and a drag bucket, which when filled is hoisted clear of the earth and pulled to the dumping position high in the air. The disadvantages of this machine are the tremendous concrete counterweights that have to be used as parts of the two towers so as to hold the cable taut. Also, the life of the cable is short and the yardage is not large enough to balance the excessive cost of replacements. The advantages are that the machine dumps from an elevation and compacts the levee and that the shore side of a levee can be reinforced without dragging the bucket over the levee. These machines are of moderate size and it is doubtful if they will ever be developed to the size or capacity of tower machines.

Tower machines consist of a head tower, a tail tower, a slack track cable, a dragline and a pull-back line. Both towers are self-propelling on crawler treads. On the head tower are drums to handle the various lines and on the tail tower a drum for winding up excess track cable. The advantages are lightweight towers easily moved, light track cable with long life, longer spans of track cable practicable, larger buckets and bucket loads greatly exceeding the nominal capacity of bucket. The heavy bucket, sliding up over the earth already deposited, compacts it very effectively. These machines have been built with buckets of a nominal capacity of 8 cu.yd. and an actual capacity of 400 cu.yd. per hour, and with working spans of 600 ft.

Both cableway and tower machines were developed to top old levees in front of which were borrowpits which could not be deepened safely, making it necessary to go farther afield for material. Both machines have to stop work during high water, but as the head towers are behind the levee, they are protected and can start operating again as soon as the water goes down sufficiently for the tail tower to move.

Draglines are mounted on crawler treads and can move about over quite soft ground. The largest so far built has a boom 200 ft. long and a bucket with a capacity of 6 cu.yd. It can dig, swing 180 deg., dump, swing 180 deg. farther and be ready to dig again in 50 seconds, and can handle about 225 cu.yd. per hour.

Clamshell dredges are very successful in digging and moving easy-digging material. The largest have 6-cu.yd. buckets and booms 225 ft. long and can dump 400 ft. from the digging point. These machines swing by gravity and the hull rolls so that the digging strains are reduced. Under suitable conditions they are extremely economical, requiring only a lever man, an oiler and a fireman for each shift.

Pipe-line hydraulic dredges swing on a stern spud as they work and do not move ahead until they have dug the desired depth in one spot. It is comparatively simple, therefore, to run a large discharge pipe to the shore on pontoons and on shore to the desired location. The sizes that are most apt to be used in this work are 20-in. and 24-in. Larger dredges are in use, but large pipe lines are hard to move, and the long narrow borrowpits will necessitate frequent moving.

Size of Contracts—A too small contract does not appeal to the average contractor, as plant and superintendence are excessive charges against the work. It also requires an excessive charge for inspection. Again, it often results in owners of small, old machines bidding at high figures. On the other hand, if a contract is too large, the rank and file of contractors are unable or un-

willing to bid and the few that do bid, bid high, so as to sublet the work in reasonable-sized subcontracts at a reasonable price, and pocket the difference. If a job can best be done with a certain type of machine, the yardage and the time allowed to do the work should be planned so as to make it economical for the contractor to put on a large modern machine and operate it to capacity for the period allowed.

Costs—Costs will tend to be higher than former costs, because material will have to be moved farther than before. This is particularly true in raising the higher levees, since the available material in the pits permitted by the present specification of 1 on 50 beginning 40 ft. from the levee toe and then a drop of 3 ft., as noted in *Engineering News-Record*, March 8, 1928, p. 400, has already been largely removed. Prices will tend to decrease because of the larger yardage to be handled per station and also because of the advance in the size and economy of excavating equipment. Competitive bidding, in the writer's opinion, will result in lower costs than would be the case if the government should undertake the work; and each portion of the work should be laid out so that the machinery that is most suitable for handling that particular portion will operate under conditions favorable to maximum efficiency.

Some Recent Points in Engineering Law

REVIEWED BY HERBERT BRAASCH
Attorney-at-Law

THESE PARAGRAPHS contain the meat of some current court rulings on cases arising in the business of civil engineering and construction. Cases are taken only from the higher federal courts and from the state supreme courts. Mr. Braasch has reduced legal terminology to a minimum. While each case is presented in as brief space as possible, it is also designed to cover all the points essential to an understanding of the factors involved. Other "Recent Points in Engineering Law" will be published from time to time. —EDITOR.

Trestle a Source of Damages

A railroad built a trestle over which trains were operated. Though properly used and constructed, noise, smoke and vibration caused by operation of powerful locomotives rendered adjoining residence property less desirable.

Owners of such property were allowed to recover such amount as the property had depreciated in market value. —*Texas Interurban Railway Company vs. Halford. Texas.*

Meaning of "Labor, Materials and Supplies"

The Riley & Bailey Construction Company built a bridge (public work) over the Alabama River. The Smith Farming Company had certain claims against it arising out of the construction work. The Union Indemnity Company by bond guaranteed payment for "labor, materials and supplies" to such persons as furnished these for the construction of this bridge. The surety company contended items of the Smith Farming Company were not of this class. These items consisted of: (1) Piling and sway bracing used for scaffold in the river to support men and superstructure materials during construction, which were not a part of the contractor's general equipment but were commonly abandoned on completion of such work; (2) ferriage in transporting men and materials from one side of the river to the other during construction period; (3) hire of men and teams for hauling machinery, timber and supplies for the contractor.

All items were held to be within the bond.—*Union Indemnity Company vs. State. Alabama.*

Blasting an "Extra" in Excavation Contract

Dionne had a contract to excavate a certain lot to a given depth. Before reaching the set depth he encountered a rock ledge. His contract required him "to excavate the earth, stone, old foundations and all other materials" within the area and to the given depth. Dionne notified the owners rock had been reached and that the removal would be extra. The owner contended at the time that the contractor was bound for this. Plans were changed decreasing the excavation depth over 1 ft. The contractor blasted and removed the rock while the owner kept a check on the blasting and rock removal costs. The contractor sued to recover blasting expenses as an "extra."

In construing the contract the court held stone covered only small pieces of rock or a piece of moderate size and did not extend to a large mass which is described as rock or ledge. "All other materials" applied only to the class of materials similar to those mentioned—that is, earth, stone and rubbish not rock. To excavate is to hollow out or make a cavity by digging or scooping and unless there is something in the contract to indicate a broader use it does not include blasting or removing rock or ledge.

The owner then contended the change of plans and contractor's work thereunder was a settlement. It was not so held, because the parties did not intend that to be a settlement, each expecting to reserve his original rights.

The contractor was allowed all blasting costs after a deduction for the excavation he was saved by the change in plans.—*Dionne vs. West Paris Building Association. Maine.*

Damages for Delay on Public Works

Awarded a public school contract by the New York City Board of Education, work to be completed in 350 working days, Brady, a general contractor, began excavations. Old buildings were in the way, and Brady notified the board of this a number of times. He continued to excavate around them until he could proceed no farther with the work. These buildings were not completely demolished by the board until a year after the signing of the contract, in part due to the board's desire to have them viewed and assessed by the referee in the land condemnation proceedings. Brady asked damages caused by the delay. His contract provided, "If work be delayed by any act of the city or board for the reason the board or the city does not own or has not obtained possession of or the right to enter upon land upon which the work is to be performed, or because of any act or omission of any employee or agent of the city or board, the board shall extend the time of completion for such period. No allowance whatever as damages or otherwise shall be claimed by or made to the contractor because of any such delays."

It was nevertheless decided that where delay is sufficiently unreasonable as to strike at the heart of the contract, the contractor is justified in abandoning the work

and recovering for damage sustained. Contracts which arbitrarily place one party solely at the mercy of the other party will receive such interpretation as is reasonable and just; so an obligation to complete in 350 working days carries an obligation on the other party to have the site ready in a reasonable time.

The board asked that damages be restricted to sums actually paid out by the contractor. He claimed damages to the extent that he was liable to sub-contractors also injured by delay. The contractor's contention was proper.—*John Brady & Company vs. Board of Education. New York.*

Land Injury Damages Measured

Oil was stored in pits formed by excavating dirt and throwing up levees. After rains and at other times water was drained from this reservoir into a deep creek, which crossed adjoining lands, depositing some crude oil and basic sediment there.

A land owner sued for injury to his property and the oil company was held liable. Question then arose as to the amount to be paid. Decided, if the injury is substantially permanent, damages would be the difference in market value before and after such deposits were made or pollutions occurred. If the damage is temporary, the measure is the difference in rental value for the period of damage.—*Standard Oil Company of Louisiana vs. Goodwin. Arkansas.*

Lien Not Lost by Acceptance of Notes

On completion of a building, the amount due the contractor was agreed upon and he was given notes for this amount, which notes he accepted. He later filed a lien against the property.

Decided, the contractor did not lose his right to a mechanic's and material man's lien by accepting the notes. —*Hiller vs. Zambetti. Florida.*

Community Rights in a Sewerage District

To determine the respective rights of the city of Milwaukee and of some smaller communities included in the territory of the Milwaukee Sewerage Commission, a friendly suit has been brought by the outlying communities. The original act of the State Legislature, in 1913, created this commission to handle the sewage-disposal problem of Milwaukee only and provided that when the works were completed they should be turned over to the city. In 1921 a new law extended the work of the commission to include "that portion of Milwaukee County which lies within the drainage area of the three rivers on which the city of Milwaukee is situated."

This new law provided methods of apportioning costs of operating and maintenance of the sewage-disposal plant and the intercepting sewer system "when the sewerage commission operates the plant." The city contends that this provision did not change the right of the commission to turn over, in its discretion, such parts of the work as are finished, or the duty of the commission to turn over the completed works to the city when everything is finished. The outlying towns hold that none of the work can be turned over to the city. The first step toward a legal decision was a resolution of the Milwaukee Sewerage Commission to turn over to the city of Milwaukee a part of the intercepting sewer system which is situated within the city limits. Some of the outlying communities obtained a temporary injunction against this step, but it was dissolved on technical grounds.

Geological Formation at the St. Francis Dam Site

Conglomerate of Poor Quality Cemented Only Loosely With Gypsum—Site Not Suitable for a Dam of Any Type

By Hyde Forbes
Engineering Geologist, San Francisco, Calif.

As the causes of the St. Francis dam failure are now recognized by all investigators, engineers as well as geologists, to lie in the natural foundation upon which the structure rested and against which it abutted, it is the writer's opinion that all the geologic weaknesses of the dam site should be pointed out in the wide discussion that is bound to follow such a catastrophe. The report of the committee appointed by the Governor of California (abstracted in *Engineering News-Record*, April 5, p. 553) states: "The geological conditions in the vicinity of the St. Francis dam are both simple and obvious." True as far as the geologist is concerned, but the fact that the dam was built on the site is evidence that they were not understood by the engineers in charge; and it is equally true that a great many other engineers under whose supervision sites are selected and dams designed and constructed do not understand "simple and obvious" geological conditions.

A Dangerous Fault—A feature in connection with the San Francisquito fault (passing through the dam site) which has not been mentioned in any report so far seen by the writer is that, while it is dead and no movement took place upon it at the time of failure, it traverses the dam site but a few miles south of the largest active fault rift in California—the San Andreas. The mapped topography indicates that the San Francisquito fault extends northeasterly to and intersects the San Andreas. This fact alone would impress itself upon a geologist as an extremely unfavorable condition for a dam structure, which could be balanced only by other particularly favorable geologic conditions, such as limited original movement, favorable strength of wall rock and favorable physical and chemical reaction of foundation rock under water contact and water pressure.

In the case of the San Francisquito fault the original movement was not limited; it was so extensive as to thrust together two formations of widely different geologic age, origin, and physical and chemical characteristics. Moreover, the intensity of the movement was such as to form a fault gouge along the line of contact and to shatter and joint the wall rocks. If watertightness and strength had been assured, except for possible movement along the fault, the site might have been suitable for an earth-fill or other type of shock-resistant dam structure. As these conditions were not met by the foundation rock, it was not suitable for a dam of any type.

The "Red Conglomerate"—It is also the writer's opinion that the so-called red conglomerate hanging-wall rock has not been described so that the engineer will understand the type of material underlying the western end of St. Francis dam. It is not a true conglomerate, but rather an alluvial fan conglomerate. The fact that the gravels and boulders lie as lenticular bodies in a matrix of sand and finely divided clay indicates that it was deposited under subaërial (continental) conditions. This

SAN FRANCISQUITO FAULT JUST BELOW DAM SITE

Conglomerate above and schist below this contact. Rock structure on both sides of fault destroyed by movement on fault long ago.

means that the material was stream-deposited alluvial material making up an ancient valley floor which has never been submerged, sorted, bedded and consolidated as are the true marine conglomerates.

In cross-section the deposit at the dam site resembles the poorly assorted materials accumulated at the base of mountain slopes in semi-arid country. The larger infrequent boulders and gravel are well rounded by water wear and stained by an "iron varnish," which, with the red color, can be ascribed to the breaking down of finely divided or pulverized ferromagnesium minerals to red iron oxide in the clay matrix. The whole has been loosely cemented with gypsum, which, at the dam site, has been largely leached out, due to the fact that the crushing and shearing resulting from movement along the fault long ago had opened it to the action of percolating water. Much of the soluble gypsum cementing material is there found redeposited in veins in crystalline form and as a white efflorescence over the face of some of the larger cracks.

When dry the west abutment material must have presented a sheared and jointed face, although apparently hard. Water making its way under pressure into the joints was absorbed rapidly by the clay matrix through capillarity, causing it to swell and become unstable physically, undergo a chemical change and break down. In this condition it was readily washed away by water under pressure. This refers to the effect of water on the hanging-wall rock; the effect upon the fault gouge would, of course, be much more marked.

The weakness of the mica schist footwall formation has been pointed out in the report to which reference has already been made. The plane of schistosity parallels the fault plane at the dam site, dipping about 40 deg. from the horizontal toward the bottom of the canyon. Striations upon the planes exposed by the slides on the east side of the canyon show that movements have taken place along them. Thus there was developed naturally considerable downhill thrust, with each plane readily parting from its supporting layers and readily sliding on the self-lubricating mica.

What actually happened in order of failure of the foundation will probably never be exactly determined. The causes and effects apparent to the writer through his investigation some five days after the failure can be briefly summarized as follows: The red alluvial fan conglomerate of the west wall and the fault gouge became saturated through absorption, increased in volume and broke down physically and chemically to an unstable mass which gave way under the water pressure upon it and allowed that section of the dam to be undermined. Deprived of its foundation, the western end of the dam broke in sections, which were carried downstream. The rushing waters readily carried away the west canyon wall material and, striking the weakened schist east wall, cut into it at the toe of the dam. Water found its way through the disturbed material and undermined the east section. The saturated mass of the bank and abutment slid down into the canyon, carrying with it the easterly section of the dam which abutted against a stripped schistosity plane and which now lies at the toe of the standing section. The east half of the central third was undermined by rapid erosion and broke from the standing west half of the central third and toppled upstream. Slides continued on the schistosity planes as the water drained from the reservoir.

The accompanying illustration is a view along the fault or contact plane. The fault gouge along the plane is shown by the excavation at *A* to be more than 1 ft. thick. The hanging-wall formation is intensely sheared and jointed, with wide vertical cracks ending at the fault plane. This picture was taken some 100 ft. below the dam site five days after the failure, and water was still seeping from the gouge and draining from the hanging-wall formation through the cracks and joints.

Culvert Costs in Highway Construction

To determine the proportionate cost of culverts in highway construction in Missouri 24 projects in five different counties in various parts of the state were tabulated. The total cost of these 24 grading projects, representing a length of 87 miles, was $589,474. The cost of drainage structures was $174,373, or 30 per cent of the total cost of construction. If a gravel surface is placed on these projects at a cost of $9,000 a mile, the cost of drainage structures will amount to 11 per cent. If a concrete surface is placed on the graded projects at a cost of $25,000 a mile, the cost of small drainage structures will be approximately 6 per cent of the total cost of construction.

"From these figures," says T. H. Cutler, state highway engineer, "we believe that the cost of small drainage structures is in the neighborhood of 15 per cent of all money so far spent on the Missouri state road system, or out of the $116,000,000 so far spent for construction, the sum of $16,800,000 represents the cost of small drainage structures."

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

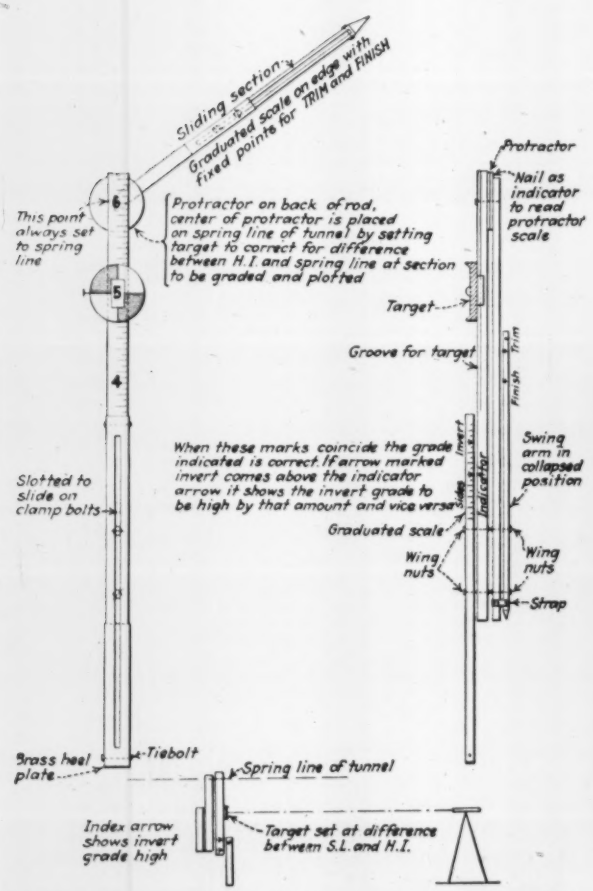
Rod for Cross-Sectioning in Tunnel

By C. C. Keely
Construction Division, Los Angeles Bureau of Power and Light, Los Angeles, Calif.

WE HAVE just finished some tunnel work at power plant No. 1 at Saugus, Calif., during which we devised a tunnel rod for cross-sectioning. Its dissimilarity from the rod described in *Engineering News-Record*, Jan. 26, 1928, p. 164, is believed to make it worthy of consideration here.

Though the construction of the rod is shown in detail in the accompanying sketch, some data concerning its use are thought advisable. With the swing arm collapsed and hanging back of the rod, the rod should be extended to its full 6-ft. length for use in finding the height of instrument from the nearest bench mark. The second step is to compute the elevation of the spring line at the section to be graded and cross-sectioned. Then adjust the target to equal the difference in elevation between the spring line and the height of instrument by moving the target up or down from the pivot. The target should be clamped in this position. Then loosen the lower wing nuts and slide the rod up or down until the clamped target intersects the line of sight. The pivot point will then be on the spring line. Read on the side of the rod the error in grade at the point where the rod is held and clamp the rod. With the rod still clamped in this position, unstrap the swing arm and rotate it to check the trim of the roof. Then loosen the wing nut clamps on the swing arm and again rotate at the desired intervals—measured in degrees on the protractor—at the same time reading on the scale on the swing arm the distance from the pivot point to the face of the rock. This will give a cross-section showing the overbreakage.

The grade index arrow is marked on the rod by extending the rod to such a length that the distance from the pivot point to the bottom of the rod is equivalent to the tunnel dimensions from the spring line to grade. Hence it is seen that if the floor is off grade and the pivot point has been set on the spring line by adjusting the target to correct for the difference between H. I. and S. L., the grade arrows will not coincide with the grade index arrow and the error in grade will be the amount shown.


Sliding section
Graduated scale on edge with fixed points for TRIM and FINISH
Protractor
Nail as indicator to read protractor scale
This point always set to spring line
Protractor on back of rod, center of protractor is placed on spring line of tunnel by setting target to correct for difference between H.I. and spring line at section to be graded and plotted
Target
Groove for target
Trim
Finish
Invert
Indicator
Swing arm in collapsed position
When these marks coincide the grade indicated is correct. If arrow marked invert comes above the indicator arrow it shows the invert grade to be high by that amount and vice versa
Slotted to slide on clamp bolts
Graduated scale
Wing nuts
Wing nuts
Strap
Brass heel plate
Tiebolt
Spring line of tunnel
Index arrow shows invert grade high
Target set at difference between S.L. and H.I.

DETAILS OF ROD FOR TUNNEL CROSS-SECTIONING

Moving a 350-Ft. Building

IN THE widening of West 22d St., Chicago, the three-story Kern Building, 350x150 ft. in plan, was moved back bodily about 40 ft. in June, 1927. This building is of brick and steel construction and no shoring was placed inside to give increased stability. A temporary wood sidewalk and crosswalk enabled the stores on the first floor to carry on their business. The rear of the building was cut off and new brick basement walls were built extending to a rear wall on the property line of the alley.

The moving was done by ordinary screw jacks or building jacks, the building being also raised by jacks from the old foundation walls and supported by sills resting on rollers on lines of rails and blockings. There

Photo by Underwood & Underwood, Chicago

BUILDING MOVED FOR STREET WIDENING
The sidewalk moved with the building

were 1,400 jacks for raising and traversing the building, which weighed about 4,000 tons and was moved 40 ft. in ten hours by 50 men.

The horizontal jacks were placed between the ends of the sills under the building and similar sills or shores butting against the old basement wall at the street, blocking and additional sills being inserted as the work progressed. The accompanying illustration shows the men at the jacks making a quarter-turn simultaneously at a whistle signal by the foreman.

The general contractor was John J. Kinnare, and the moving was done for the owner of the building by Crowe Brothers, Chicago, house movers and shoring contractors.

Air Blower Removes Sticks and Débris From Concrete Aggregates

By B. E. Torpen
Superintendent of Design and Construction, Bull Run Storage Project, Bull Run, Ore.

ON THE construction of the Bull Run dam for the water supply of Portland, Ore., the contractors encountered a difficult problem in trying to screen out the vast amount of small sticks and débris in the sand and gravel which were taken from the river gravel bars in a heavily wooded district. A large portion of the sticks had a specific gravity slightly greater than 1, and so could not be floated or screened out. Finally air blowers were suggested as a possible solution and were tried with entirely satisfactory results.

Tests of concrete made from aggregates containing 2 per cent sticks and débris by volume showed 15 per cent loss in strength, very poor workability and some loss of weight. At times the percentage of sticks in the pea gravel was as high as 25 per cent of the volume, and this material had to be wasted. After installation of the blowers, however, the sticks and débris caused no more trouble. The specific gravity of the foreign matter being about 1 and that of the gravel about 2.7, it was a simple matter to allow the gravel to drop past in a thin sheet and regulate the blowers to remove the débris. Excess water in the gravel was also blown off; this was of some value, as after inundating the sand on this job it is necessary to draw off as much as 0.5 to 1.7 cu.ft. of water, depending upon the grading of the sand.

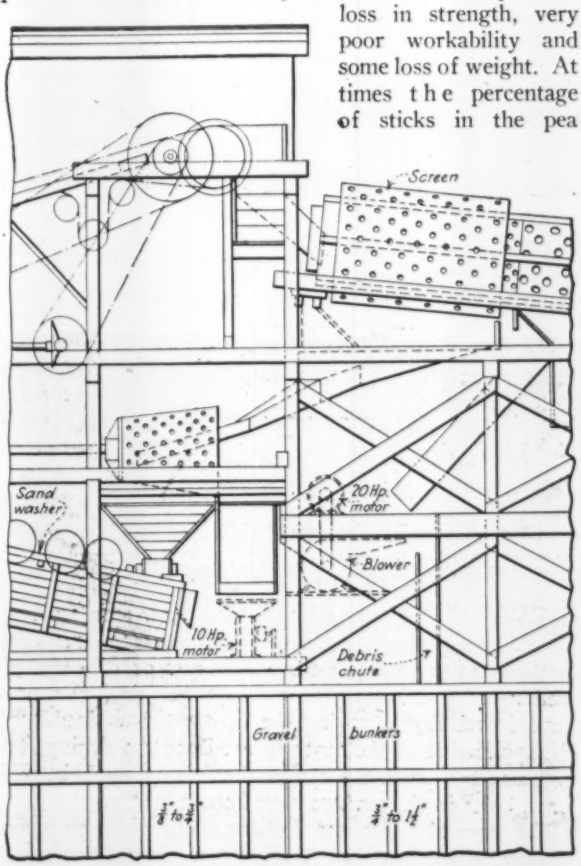


FIG. 1—LOCATION OF BLOWER IN SCREENING AND WASHING PLANT

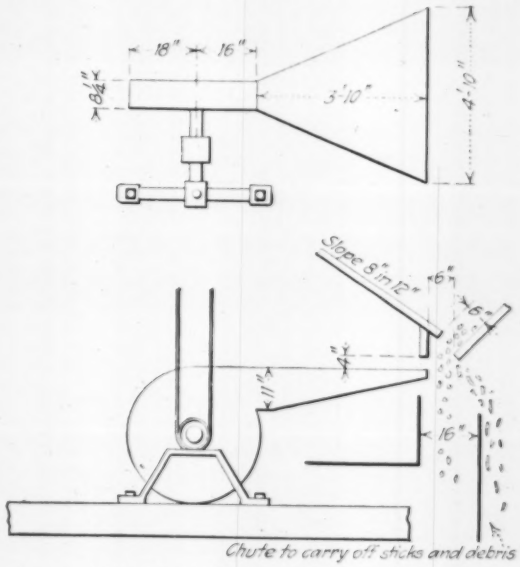


FIG. 2—DETAIL OF BLOWER UNIT

Without the blowers it would have been impossible to use several thousand yards of local gravel economically and other aggregate would have had to be shipped in at great expense. Bent Brothers of Los Angeles, Calif., were the contractors.

Keeping Blueprint Files Intact

By Alfred B. Osborne
Engineer, Larkin Company, Inc., Buffalo, N. Y.

THE method of keeping sets of blueprints intact, described in the Job and Office section of *Engineering News-Record*, March 29, 1928, p. 523, has been in use in our office for many years, but with two refinements, which at least in our own case we have found to be advantageous. Instead of using stove-bolts, we use ordinary wood screws, which after the set is made up are filed off flush with the back strip, thus providing that when the set is laid down on a table or other materials, there is no possible tear caused, as might be by the bolt heads or nuts, the heads of our screws being also flush.

In addition, instead of having the name of the set on the stick in the middle, where it is not readily seen without moving each set out of the way, we have a title imprinted plainly on the outer 4 in. each side, so that they can be readily identified at once.

A common practice with this method of filing sets of blueprints is to give the supporting strip of the bracket a steep slope forward and to cut notches in it to support the binding strips. This arrangement exposes the lettering on the face of each strip.—Editor.

Semi-Cylindrical Steel Caisson Aids in Cutting Sea Wall

IN ENLARGING a steam power plant of the Pacific Gas & Electric Company at Oakland, Calif., it became necessary to install a 48-in. cast-iron pipe for circulating water, the intake of the pipe being in a concrete sea wall about 20 ft. below high-tide level where the concrete is 10 ft. thick. Because of soft bottom a sheet piling cofferdam was not feasible and instead a semi-cylindrical steel caisson was built to enable workmen to cut through the concrete below water level. The caisson, with a radius of 4½ ft., was made of plates varying in thickness from ⅜ in. at the lower end to ¼ in. at the top, stiffened by five steel angles welded to the outside of the shell. It was about 26½ ft. high and weighed 4½ tons. The bottom was closed by a ⅜-in. plate, and 6-in. channel irons were welded to the inner edges to provide supports for the wood and rubber seal used to make a watertight joint with the face of the concrete wall.

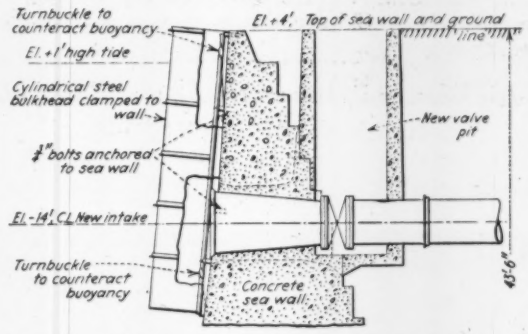
In order to insure a tight fit against the irregularities of the concrete sea wall a 6x6-in. timber frame was built up with dimensions such that the timbers could later be fitted into channels on the face of the caisson. Before being fitted to the caisson, however, this timber frame was lowered into correct position on the face of the wall and a diver was sent down to scribe upon it the outline of the concrete in the exact location where the timber frame would again be placed against the face of the wall when the caisson was set in position.

PREPARING TO LOWER THE SEMI-CYLINDRICAL STEEL CAISSON
Note irregular surface of timber-supported rubber gaskets shaped to fit the face of the concrete wall.

From Job and Office

Hints That Cut Cost and Time

When the timber frame had been cut to the mark scribed upon it, there was attached to this irregular face a heavy rubber gasket 4 in. wide and 1 in. thick with a half-round section in the center, bringing the total thickness to 2¼ in. The timber frame was bedded to place in the channel iron with the aid of hot asphalt


Turnbuckle to counteract buoyancy
El. +4' Top of sea wall and ground line
El. +1' high tide
Cylindrical steel bulkhead clamped to wall
New valve pit
1" bolts anchored to sea wall
El. -14' CL New intake
Turnbuckle to counteract buoyancy
Concrete sea wall
45'-6"

ELEVATION SHOWING CAISSON IN POSITION AGAINST SEA WALL

used as a cementing material. The completed caisson was lowered to place on the concrete wall by a truck-mounted crane.

Initial fastening to the sea wall was accomplished by two sets of bolts that had been placed in the upper part of the concrete wall during low-tide periods. These bolts were fastened to steel struts across the face of the caisson, and as water was pumped from the inside three more sets of bolts were successively put in and fastened to struts lower down on the face of the caisson. The up-thrust of 26 tons was cared for by four 1-in. turnbuckle stays extending from anchor bolts in the concrete to the stiffening ribs of the caisson. Exterior water pressure amounting to 75 tons maximum compressed the rubber gaskets to a thickness of about ¼ in., completely sealing the joint between the caisson and the sea wall.

With this arrangement the water was successfully excluded during the operation of cutting through the concrete, and the work was completed on time in a satisfactory manner.

Dragging Tar-Treated Road Surfaces Reduces Spattering

By George E. Martin
Consulting Engineer, General Tarvia Department, The Barrett Company, New York

SEVERAL highway officials who have been working on the problem of modifying surface treatment methods so as to retain the advantages of cold surface treating material and produce a quicker drying surface have found that dragging the tar-treated surface after the application of the cover has reduced the drying time and also has produced a smoother riding road, because small holes in the surface have been filled up.

For several years the Indiana state highway maintenance department has dragged tar surface treatments immediately after the application of the cover, using a long-base drag. This dragging action pushes the pieces

From Job and Office

For Contractor and Engineer

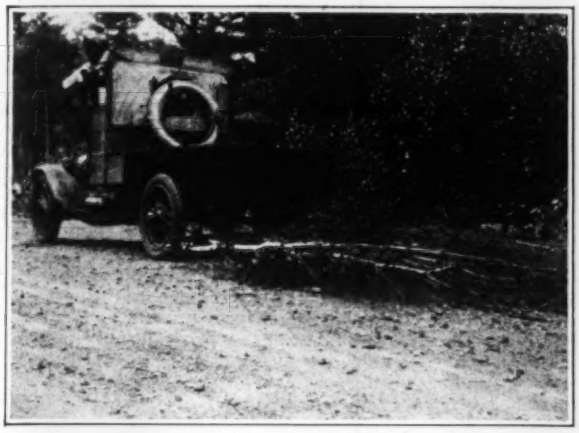


FIG. 1—BIRCH TREE DRAG FOR SEASONING AND EVENING TAR-TREATED ROADS

of aggregate about over the road surface and coats each particle with tar, thus practically producing a tar and stone mixture. This procedure accelerates the setting-up action of the tar by exposing it to the air in thin films and also fills small depressions with the tar mixture.

The Maine state highway maintenance department has introduced two types of drags that are used for the same purpose, the brush drag and the chain drag. The brush drag, Fig. 1, is made by cutting small trees (Maine generally uses birch trees) and fastening them behind a truck with the butt ends forward. The chain drag consists of an 8-ft. timber with a series of loops of 1½-in.

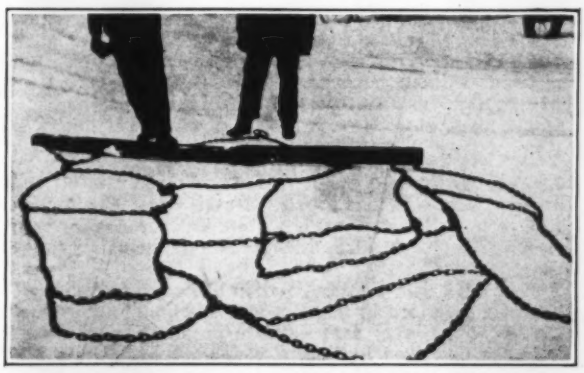


FIG. 2—CHAIN DRAG WITH TIMBER RIDING FREE FOR TAR-TREATED ROADS

chain attached to the timber and dragging behind it. The loops vary from 4 to 8 ft. in length. Old skid chains can be used. The timber acts only as a spreader and does not drag on the surface.

Each of these drags is attached behind a small truck, which should operate at from 8 to 12 miles per hour for the best results. The surface is dragged at least four times. The chain drag seems to work somewhat better than the brush drag in pulling the tar-coated aggregate into depressions in the surface and thus producing an easier riding road.

Chute for Drainage Water Prevents Bank Cutting

THE FIRMLY compacted silt that constitutes much of the floor of Imperial Valley will stand on practically vertical slopes wherever it remains dry in the original water-laid formation. When subjected to flowing water, however, it literally dissolves and is carried away even by slow-moving currents. Under these conditions great care is required in the disposal of drainage waters of the Imperial Irrigation District that have to be conveyed from shallow ditches into the natural drains at considerably lower levels.

CONCRETED DROP FOR DRAINAGE WATER IN IMPERIAL VALLEY

The accompanying illustration shows a typical scheme of getting waste from the drainage ditches into the bottoms of natural channels 30 ft. or more below. This method does not involve the waste of useful land, as deep cracks along the precipitous faces of these natural waterways prevent irrigation for some distance back from the brink.

Job and Office Notes

WHEN IT BECOMES NECESSARY TO DAM A STREAM of several inches to a foot or two or deflect it temporarily from its natural flow a big improvement can be made on the usual practice of placing bags of cinder or gravel across the stream with a little more labor and slight additional cost and a much more reliable and satisfactory result can be obtained. A few stubs of old reinforcing steel bolts or short-length pipe driven in the stream bed to a depth of a foot or two and strips of light poultry mesh wire placed over the stubs before placing the bags is such a satisfactory arrangement. After the bags of cinders are in place to the desired height, wire can be drawn up over the bags from the up- and down-stream sides of the dam and sewed along the top of the dam with suitable wire fastenings. Loose cinders can then be placed on the upstream side until the dam is sufficiently watertight—*F. M. Harm, Rochester Gas & Electric Corporation.*

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

On the Theory of Initial Tension in Rivets

Sir—The paper, "Tensile Working Stress for Rivets," by Prof. C. R. Young, *Engineering News-Record*, Feb. 2, 1928, p. 188, brings up several points of interest about which there is some difference of opinion.

Professor Young states that no increase of stress on a rivet is possible until the load imposed has exceeded the initial tension existing in the rivet. The statement apparently ignores the relation between stress and strain of elastic bodies. The following demonstration shows that, regardless of the amount of initial tension in the rivet, any additional load must cause additional stress in the rivet. This additional stress may be small enough to preclude its consideration for practical purposes. On the other hand, it may be quite large. In Fig. 1 as the rivet R, which has been driven through a plate W, cools, it tends to shrink. This tendency is resisted by the plate W, causing tension in the rivet and compression in the plate, the two being equal and opposite for equilibrium, or $\Sigma T_1 = \Sigma C_1$.

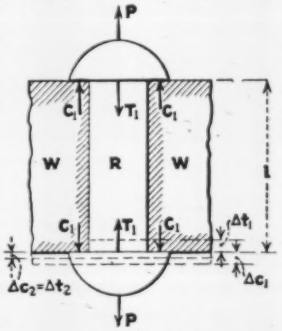


FIG. 1—DIAGRAM SHOWING EQUALITY OF STRAIN IN RIVET AND PLATE DUE TO INITIAL STRESSES

Now let Δt_1 = strain in rivet R due to initial tension, Δc_1 = strain in plate W due to initial compression and l = length of rivet = thickness of the plate (after each has been stressed and equilibrium obtained).

Then $l - \Delta t_1$ = the length of rivet R in unstressed state and $l + \Delta c_1$ = thickness of plate W in unstressed state.

Assuming an initial 10,000-lb. tension in the rivet (which is also initial compression in the plate), an additional load P, 8,000 lb., is brought to act upon the rivet as shown in Fig. 1. If Professor Young's statement is correct, the stress in the rivet will not be increased. Since the laws of statics still apply, are we to assume then that the additional load P simply releases some of the compression ΣC_1 existing in the plate, reducing it to a lesser amount, ΣC_2, such that $P + \Sigma C_2 = \Sigma T_1$? But ΣC_1 cannot be reduced to ΣC_2 without an accompanying change in the strain Δc_1, which would increase l, the thickness of the plate. But l cannot be increased without causing a like change in the length of the rivet. Since the strain in the rivet is increased, the stress must be proportionately increased. So it is evident that the additional load P must be equilibrated both by a decrease in ΣC_1, the compression in the plate, and an increase in ΣT_1, the tension in the rivet.

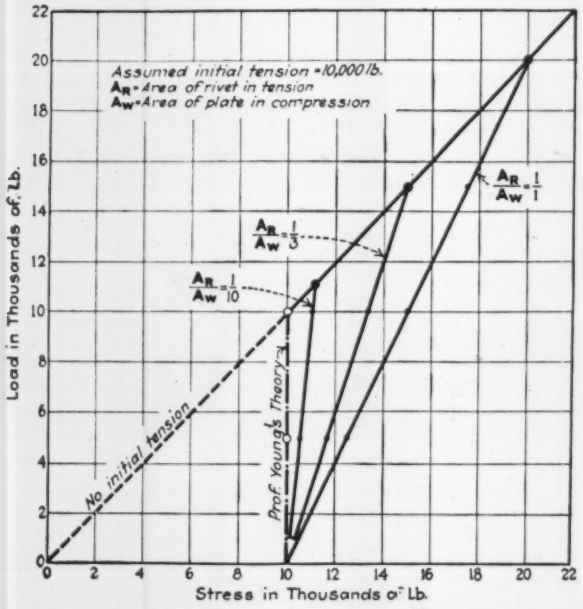


FIG. 2—RELATION BETWEEN LOAD AND RIVET STRESS
Note that Professor Young's theory, that no increase in rivet stress is possible until the imposed load exceeds the initial tension, is plotted.

The question then arises, "What is the distribution of the load P between the rivet and plate?" Since both the rivet and the plate are steel, their relative rigidity is measured only by the ratio of their areas. If the area of the plate were the same as the area of the rivet, any additional load P would be divided equally between the plate and the rivet up to that point where the initial compression in the plate is entirely released. In most cases, however, the area of the plate over which the initial compression is distributed and the form of distribution are matters of some uncertainty. There is no question that the area of the plate taking compression is greater than the area of the rivet. Fig. 2 is plotted to show how the stress in the rivet is affected by different ratios of area of rivet to area of plate. If the area of the plate is three times the area of the rivet, then 25 per cent of the additional load causes increased stress in the rivet. But if the area of the plate is ten times the area of the rivet, then only 9 per cent of the additional load goes to the rivet. Note that after the initial compression is released in the plate the rivet must take all the additional load and the load-stress curve is a straight line inclined at 45 deg.

It is evident that if the ratio of area of plate to area of rivet is large and if the initial tension in the rivet is large, the subsequent increase in stress due to an additional load will be quite small. This may explain why no deformation was apparent in Professor Young's tests until the imposed load had become quite large.

It must be borne in mind that the initial tension on rivets cannot be very easily determined, if at all. In view of this uncertainty it seems unwise to assign normal working stresses to rivets in tension. The writer would not exceed 35 per cent of the normal tension unit stress in any case. This is about in line with the requirements of some existing specifications. Tension rivets should be avoided as much as possible, but it is often difficult economically to design some details without using them.

H. E. WESSMAN,
Instructor, Structural Engineering,
University of Illinois.

Urbana, Ill.,
Feb. 13, 1928.

Crests for Thin Overpour Dams

Sir—In regard to the article "Novel Crest Design for Thin Overpour Dams," by J. C. Stevens, in *Engineering News-Record*, Feb. 9, 1928, attention should be called to the following facts:

The Hubbard dam Flathead Indian project was completed in 1923 and described in the *New Reclamation Era*, December, 1924. The Gerber dam Kalmath project was completed in 1925 and described in *New Reclamation Era*, December, 1925. Both of these are thin arch dams with an overflow spillway. The crest of the spillway is extended over the downstream face, to throw the water away from the base of the dam. Both are aerated from each end of the spillway.

Both of these ideas, the overpour lip and aeration by breaking through the nappe, were considered commonplace in the designing office of the Bureau of Reclamation when the writer was employed there, and they were used in several preliminary designs of dams not yet built. The piers for drum gate crests in the bureau designs are especially designed to supply air to the space below the crests.

In view of these facts it seems to the writer that there is nothing novel in the article of Mr. Stevens except the idea of a patent.

C. H. HOWELL,
Designing Engineer for the
J. G. White Engineering Company, in Mexico.

Mexico City, March 9, 1928.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Road Builders' Association Forms City Officials' Division

Following the success that has attended the formation of the division of county highway officials of the American Road Builders' Association, there has now been authorized the formation of a city officials' division. This new division will be governed by its own constitution and bylaws and will elect its own president, vice-president and directors. There will be several committees appointed from the officials of different cities throughout the United States, and the reports of these committees will be presented at the next convention. The organization meeting for the division will be held in the early part of June at the headquarters of the association in Washington. It is urged that all city officials attend and take an active part.

Grand Jury to Investigate Queens County Affairs

Following the resignation of Maurice P. Connolly, President of Queens Borough, New York City (*Engineering News-Record*, April 5, 1928, p. 562), all proceedings for his trial for removal by Governor Smith on sewer scandal charges were automatically ended, but within three days, or on April 5, the Governor ordered an investigation before a grand jury at a special session of the state supreme court, in Long Island City. This order was based on a report to the Governor by Commissioner Clarence J. Shearn, who was conducting the investigation for the Governor, declaring, in the language of the Governor, the finding of "criminal waste of public funds in Queens County in very large amounts, neglect of duty on the part of former Borough President Connolly and minor borough officials and violations of the penal law by several persons." Evidence in the case will be presented by Emory R. Buckner, the lawyer who has been collecting evidence for some time past. May 7 has been set for the first grand jury session.

Americans Invited to German Water and Sewage Meeting

At the annual meeting of the German Chemists Association, May 30 to June 30, in Dresden, the Water Chemistry Section, a union of German water and sewage experts, will formulate a program of a series of lectures on various topics concerning water and sewage disposal practice and of inspections of modern water-works, sewage and trade waste disposal plants.

The secretary, Dr. Hermann Bach, Johannastrasse 16, Essen, announces that American experts in the field of water and sewage practice who may be in Europe at that time are invited to be present and participate in the discussions. Further particulars concerning the meeting will be furnished them if they will communicate with Dr. Bach.

Plans Announced for A.W.W.A. Convention and Excursion

An excursion trip of 24 days, of which four would be devoted to the meeting in San Francisco, has been announced by the American Water Works Association in connection with its 48th annual convention. Going out there would be major stops at Colorado Springs, the Grand Canyon and Los Angeles. After the convention, June 11-15, the excursion party would go north, with stops at Portland, Ore., and Victoria, B. C., then east, with a stop for a 3½-day tour through Yellowstone Park.

Three alternative return routes are offered, two of which are through western Canada. The cost for the round trip outlined is $456 for a lower berth, with other possibilities. For excursion reservations application should be made to John S. Warde, Rensselaer Valve Company, 50 Church St., New York City. Preliminary programs of the convention may be had from B. C. Little, secretary A.W.W.A., 170 Broadway, New York City.

Cleveland to Vote on Change From Manager to Mayor

The city manager plan and the proportional representation method of electing councilmen are again under attack at Cleveland, Ohio. Charter amendments to eliminate both will be voted on at the presidential primary election, April 24 but, if carried, a mayor to take over the executive powers of the manager would not be elected until November, 1929, instead of immediately, as in the amendment voted down last November.

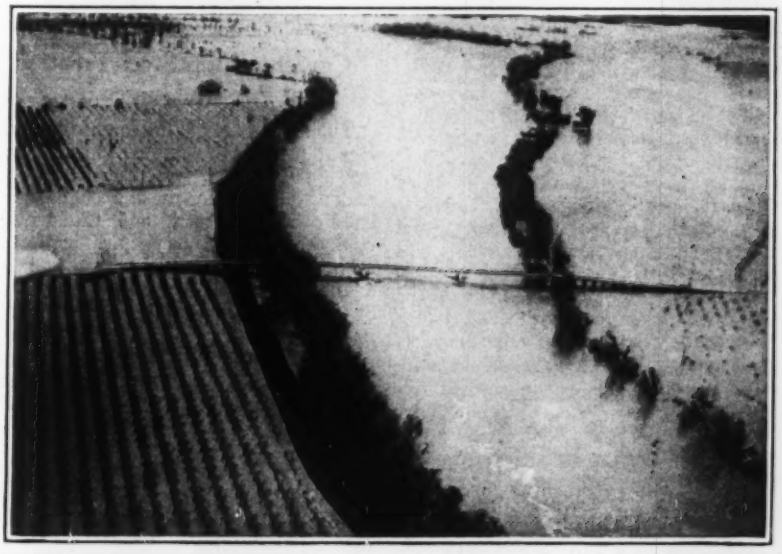
St. Louis Starts Huge Paving Program After Delay

The effort of the city of St. Louis to bring out a big program of public works in 1928 in part as an aid toward reducing the unemployment difficulty received a big impetus when the Supreme Court of the State of Missouri on March 17 handed down a decision validating the amendments to the city charter and removing the injunction against municipal contracts which had been in effect since the late summer of 1927.

The decision of the court held the amendments to the St. Louis charter valid in every respect and all ordinances passed thereunder to be correct, thus making it practicable for the banks to purchase special tax bills issued by the city under the new charter.

The city's program for 1928 involves

FLOODED AMERICAN RIVER NEAR SACRAMENTO



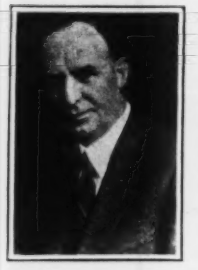
Floods in the American and Sacramento rivers in California resulting from melting snows in the Sierra Nevada Mountains have caused great damage and some loss of life. The above view shows the H St. bridge near North Sacramento and the adjacent flooded hop fields.

the expected expenditure of nearly $12,000,000 on sewers and paving alone. Of the paving work, nearly $2,000,000 worth is now under contract and about $5,500,000 worth remains to be let, this work being divided in lettings scheduled weekly from this time forth. The first of the big lettings is set for April 24, when bids will be received on asphalt and asphaltic concrete pavements in an amount of nearly $500,000.

The sewer work, involving contracts for about $9,000,000 and probable expenditure of $4,500,000 during 1928, will also be the subject for receipt of bids during the spring and summer of this year. This program is more than 50 per cent in excess of the greatest amount St. Louis has heretofore done, and should be a considerable factor in offsetting reduced volume of building construction.

Road Builders Association Appoints Chief Engineer

The American Road Builders Association announces that C. N. Conner has been appointed chief engineer for the association. Mr. Conner has had wide experience as a road builder and as a committee worker, having recently been chairman of the committee on low cost improved roads, operating under the Highway Research Board. After his graduation from Tufts College in 1908, Mr. Conner worked for three years in railroad construction and later was assistant engineer with the Bureau of Public Roads in the Philippine Islands. After positions with both the War and Navy departments, he became assistant engineer with the Delaware State Highway Department and later state construction engineer for the North Carolina Highway Commission. During 1925 and 1926 Mr. Conner was chief engineer of the Mexican Federal Highway Commission.



Mr. Conner's work in the American Road Builders Association will consist of co-ordinating the activities of the committees of the several divisions and arranging for the committee reports. As at present outlined, the program for the 1929 convention of the association will consist essentially of reports of the chairmen of the various standard committees.

San Francisco to Vote May 1 on Two Water Bond Issues

Two bond issues, totaling $65,000,000 and both affecting the future water supply of San Francisco, are to be voted on by the citizens of that city on May 1. One issue, for $41,000,000, is for the purchase of the Spring Valley water system and its reservoirs in and near the city; the second issue is for $24,000,000 to build the Coast Range and valley divisions of the Hetch Hetchy aqueduct, which will complete the unfinished gap and deliver mountain water from the Tuolumne River into San Francisco.

New York Governor Rejects Toll Bridge Bills

Three bills providing for the construction and operation of toll bridges by private corporations have been vetoed by Governor Smith of New York. One of the bills provided for the incorporation of a company to construct a bridge across the St. Lawrence River in the vicinity of the Thousand Islands to a point in the Province of Ontario. The second bill provided for the incorporation of a company to construct and operate two bridges across the Niagara River. The third was an omnibus measure giving to the State Land Board power to give grants of lands under water owned by the state for private bridge construction.

In a memorandum accompanying the vetoes Governor Smith said: "As a general policy it is undesirable to grant franchises for toll bridges to private individuals or corporations. These three bills are disapproved because: (*a*) Governments or states can finance such projects at lower cost; (*b*) such improvements are in their very nature public, and should therefore be owned by the public; (*c*) to authorize privately owned toll bridges is a step as backward as to authorize privately owned toll highways; (*d*) if it pays private corporations to erect these bridges, it will certainly pay the state to do it. If tolls are to be charged, the state should be the recipient of the tolls and they should not be in excess of what is required to operate and maintain the property, pay the interest on the bonds and make the necessary annual contributions to the sinking fund for their retirement."

Conference on Steel Treating at Purdue University

The second annual conference on steel treating will be held at Purdue University, Lafayette, Ind., May 10 and 11 under the direction of the engineering extension department and the department of practical mechanics, with the school of chemical engineering and the Indianapolis and Fort Wayne sections of the American Society of Steel Treating co-operating.

Zoning Act Unanimously Adopted by New Jersey Legislature

After a long struggle over a series of proposed amendments both branches of the New Jersey Legislature of 1928 passed without opposing votes a zoning act to put into effect the constitutional amendment authorizing zoning, adopted by a large majority in a referendum vote in November, 1927. A Senate amendment stricken out in the House and left out on final passage read: "Nothing herein contained shall authorize regulations that actually result in the taking of private property for a public use without just compensation." Another Senate amendment, designed to prevent the adoption of a rule common in zoning ordinances to the effect that after the destruction of any nonconforming building by fire or otherwise it cannot be restored to a nonconforming use was modified by the House to govern only in cases of "partial destruction."

Bills Provide Additional Grade Elimination in New York State

Three important grade elimination bills passed by the New York State Legislature have been signed by Governor Smith. The Hofstadter bill provides a measure under which the city of New York can negotiate with the New York Central Railroad Company for the elimination of the tracks on Eleventh Ave. The general improvement of the whole West Side district through which the New York Central operates also comes under this bill. Of the estimated cost of $100,000,000, approximately $83,000,000 will be borne by the railroad company, the remainder divided between the state and the city.

Elimination of grade crossings outside the cities of New York, Buffalo and Syracuse are provided for in the Thayer bill. The city of Buffalo is taken care of by the Hickey bill, and Syracuse by the Fearon bill, though the latter measure has not yet been signed by the Governor.

The cost of all work, where it is purely grade-crossing elimination work, will be paid 50 per cent by the railroad involved, 40 per cent by the state and 10 per cent by the county in which the work is done. This allocation of cost was approved last November as a state constitutional amendment. The county's proportion of work done in Erie and Onondaga counties will be paid by the cities of Buffalo and Syracuse, respectively, whenever the elimination occurs within the city limits. For grade-crossing elimination work outside the city of New York $40,000,000 has been appropriated by the Hewitt bill, which Governor Smith has signed.

Completes Investigation on S. C. Highway Department

The South Carolina legislative committee which was formed to investigate an alleged deficit in the state highway fund finds that the deficit did not mean a shortage and was not attributable to neglect on the part of any individual, but was the result of the operation of several state highway laws which in effect caused the money to be available but not received and credited to the highway fund.

Among the committee's recommendations were the following: (1) Amendment of the law to make the chief highway commissioner explicitly an agent of the commission instead of having co-equal authority; (2) more frequent

meetings of the commission; (3) more rigid supervision of road construction work, and more rigid tests of completed projects before acceptance; (4) purchases in excess of $1,000 to be made on competitive bids; (5) transfer to the railroad commission of the department supervision of motor vehicles operating for hire, including buses.

In conclusion, the report paid tribute to Charles H. Moorefield, state highway engineer, for his signal services in the development of the state road system.

Foundations of St. Francis Dam Again Indicted

Two further engineering reports on the St. Francis dam failure were rendered last week. A board appointed by the District Attorney of Los Angeles County reported on April 4, and a board named by the city council made its report on April 10. Both reports, like that of the Governor's board summarized last week, charge the failure to defective foundations.

The district attorney's board, composed of E. L. Mayberry, C. T. Leeds, W. G. Clark, R. E. Sedgwick and L. L. Johnson, the latter two being geologists, stated that an error of judgment was made in constructing the dam, that the geological formations at the site had not been studied adequately and that the failure was due to defective foundation material, some of which became soft and yielding when saturated. The board expresses the opinion that it was not economically feasible to build a safe dam at the site chosen.

Dr. Elwood Mead, Louis C. Hill, Gen. Lansing H. Beach and D. C. Henny, reporting to the city council, also blamed the collapse of the dam on defective foundations. A fuller summary of their findings is expected to be available later.

Favor Large Sacramento River Storage and Power Project

The proposed Kennett dam on the upper Sacramento River in California, which could ultimately store 10,000,000 acre-ft. and make possible the development of 500,000 kw., is a major feature of Bulletin 13, just issued by the division of engineering and irrigation of the California Department of Public Works.

The Sacramento River above the mouth of the Feather has a 12,100-square mile drainage area and a mean seasonal runoff of 12,400,000 acre-ft., or one-third the runoff of the entire great central valley of California. Large reservoir capacity is required to equalize this runoff and to make the surplus available for use. Development is, therefore, dependent upon the feasibility of constructing storage works of large capacity in the main Sacramento River. A reconnaissance survey run the entire length of the main river channel in search of a large-capacity reservoir site resulted in naming the Kennett site as the only feasible location for a development of the necessary size. At the Kennett dam site diamond drill borings showed foundations adequate for the creation of the 10,000,000 acre-ft. capacity mentioned.

The "Co-ordinated Plan for the Development of State Water Resources" proposes the construction, among others, of a dam at the Kennett site to the initial height of 420 ft. Such a dam would create a reservoir capacity of 2,940,000 acre-ft., which could be expected to yield annually 2,838,000 acre-ft. of water equalized for irrigation needs when operated primarily for this purpose. It would reduce the maximum flood flow in the Sacramento River below from 278,000 to 125,000 sec.-ft. and would warrant the construction of a 400,000-kw. power plant.

Washington Notes

Flood-Control Bill to Be Debated Long in House—Names Suggested For Board of Review—Road Aid

By Paul Wooton
Washington Correspondent

FULL opportunity to discuss and to amend the flood-control bill will be insisted upon by the rules committee of the House of Representatives, it was indicated at a hearing held April 5. It was apparent that members of the committee regarded the bill, in its present form, as being too broad and indefinite. As a result it is believed that enough time will be allowed for the consideration of the bill to give all members desiring to speak on the subject an opportunity to be heard. It is expected that the bill will be materially amended on the floor of the House.

It has been made quite clear at the White House that the President will veto the bill in its present form, although assurances have been given that the President would sign a bill such as the one which the commerce committee first reported to the Senate. The bill is expected to come before the House the week of April 23.

As it seems apparent that the board of review will be retained in the bill, discussion already has begun of the names of those who will be urged as the civilian members of that board. Among the names brought forward are: Arthur E. Morgan, C. E. Grunsky, Mortimer G. Barnes, Baxter Brown, J. Waldo Smith, Gardner S. Williams and R. I. Randolph. In addition it is known that many candidates will be suggested from points along the river.

The action of the flood-control committee in attaching the Sacramento River project to the Mississippi River bill has brought forth strong protests from those who feel that each project should be handled in a separate measure.

Public Works Bureau

Those favoring the transfer to the Department of the Interior of the public-works functions of the federal government on April 7 completed the presentation of their side of the case to the House committee on expenditures in the executive departments. The week of April 9 was devoted to the taking of testimony from those who oppose the plan.

Dr. George Otis Smith, director of the U. S. Geological Survey, in his testimony before the commission, said: "The Wyant bill represents the sentiment of engineering bodies generally, and thus the movement for the transfer of engineering activities to the Department of the Interior is wholly of outside origin. From the standpoint of the engineers of the country it is absolutely essential that the organization in control of public works should be civilian and that the officers in charge should not have a mere temporary tenure of office."

He illustrated the contrast between the two procedures from his own experiences as the chief of an engineering organization for 21 years, during which period the three branches of the Geological Survey having most to do with engineering had been administered by only two chief hydraulic engineers, two chief topographic engineers, and four chief geologists. During that period there had been, however, nine chiefs of engineers in the Engineer Corps. The specific advantages of co-ordinated administration of all the public works were given as economy in overhead, saving in time through better access to all engineering data and prevention of too great overlap of endeavor. Another argument bearing upon the general public benefit was that integrated control of all public works would afford the opportunity for a better contribution to the economics of the country. The unified administration of construction work would make it possible to adjust programs to meet the local or general labor and material conditions, whether the condition was one of scarcity or surplus.

Other witnesses who appeared in support of the measure were Gardner S. Williams, chairman of American Engineering Council's committee on government reorganization; A. W. Berresford, president, American Engineering Council; Edward C. Finney, Assistant Secretary of the Interior; E. O. Griffenhagen, chairman, public-works committee, American Engineering Council; Farley Osgood, an engineer specializing in organization matters, and R. C. Marshall and D. H. Sawyer, of the Associated General Contractors.

Highway Legislation

As this is written, the committee on roads of the House of Representatives is on the point of reporting out two important road bills. One is the measure authorizing the appropriations for the next two years at the rate of $75,000,000 per year. The other would permit Western states to concentrate funds on interstate roads. This does not increase the amount of federal aid in any state, but allows the state to release funds intended for other projects to expedite construction on the through routes.

Personal Notes

WALTER H. WEISKOPF has severed his connection with Weiskopf & Pickworth, consulting engineers, New York City, and is now with the Carnegie Steel Company, New York City.

CHARLES W. GENNET, JR., for several years managing engineer of the rail inspection department of the Robert W. Hunt Company, has been appointed vice-president of the Sperry Rail Service Corporation, which plans to undertake rail and track inspection with devices for detecting transverse fissures in rails and recording the condition of railway track. Mr. Gennet has offices in the Railway Exchange Building, Chicago, and will be in charge of all track-inspecting operations.

ASA HALL MORRILL has been appointed chief engineer of the Maine Central Railroad, with office at Portland, Me., succeeding Bertrand Thorp Wheeler, deceased. After his graduation from the Massachusetts Institute of Technology in 1892 Mr. Morrill entered the service of the New Haven Railroad, with which he remained until Feb. 1, 1913, when he became engineer of construction and chairman of the valuation committee of the Maine Central. Some of the jobs completed under his direction are the double tracking of the main line from Waterville to Clinton, the construction of bridges across the Kennebec at Augusta, and across the Sheepscot River at Wiscasset, the new Rigby yard and the railroad end of the new railroad-highway bridge across the Kennebec River at Bath, completed last fall.

PAUL BROWN, city engineer of Indianapolis a year or more ago, has become assistant park engineer. Mr. Brown held the position for several years before being named city engineer.

J. W. HAMILTON, of the Washington state highway engineering department, who has been in charge of the engineering work in the Yakima district, has been appointed maintenance engineer for the state. A. C. SIMPSON, for nine years Mr. Hamilton's assistant, has been made district engineer for the Yakima territory.

SHIRLEY W. ALLEN, who for the past four years has served the American Forestry Association as forester at Washington, has resigned to become extension professor of forestry in the School of Forestry and Conservation at the University of Michigan. He will take up his new duties April 1.

BILL N. TAYLOR, formerly engineer for the Standard Oil Company of California at Colorado, Tex., has been appointed city manager of Longview, Tex. Mr. Taylor is a graduate of Texas A. & M. College, class of 1919, an associate member of the American Society of Civil Engineers and an associate member of the International City Managers Association. With the exception of one year of engineering teaching, he has spent his entire time since graduation in oil-field engineering, four years of which were in Mexico and Venezuela.

Major R. Y. STUART has been promoted from assistant forester to chief of the Forest Service, U. S. Department of Agriculture, succeeding Col. William B. Greeley, who has resigned to become manager for the West Coast Lumbermen's Association.

D. J. HUNT has been appointed an assistant engineer with the U. S. Bureau of Reclamation on the Kittitas division of the Yakima project at Ellensburg, Wash. Mr. Hunt is a graduate of the Colorado Agricultural College, and has recently been engaged in highway engineering in Kansas. Formerly he was a junior engineer on the Shoshone project, Wyoming, and later an instructor at the Kansas State Agricultural College.

Engineering Societies

Calendar

Annual Meetings

BUILDING OFFICIALS CONFERENCE OF AMERICA, Springfield, Mass.; Annual Meeting, Detroit, Mich., April 24-27.

AMERICAN WELDING SOCIETY, NEW YORK; Annual Meeting, New York, April 25-27.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 7-10.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, El Paso, Tex., June 4, 5 and 6.

AMERICAN WATER WORKS ASSOCIATION, New York; Annual Convention, San Francisco, week of June 11.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Meeting, University of North Carolina, June 25.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS, Chicago; Annual Convention, New York, June 25-27.

THE BUILDING OFFICIALS' CONFERENCE OF AMERICA will hold its fourteenth annual meeting in Detroit April 24-27. Among the papers listed on the program are "Steel Joists," by W. C. Muehlstein, building engineer, Industrial Commission of Wisconsin; "Future of Metal Lath as Fire Protection," by Wharton Clay, Metal Lath Manufacturers Association; "The Standard Fire Test," by Rudolph P. Miller, consulting engineer, New York City; "The Severity of Building Fires," by S. H. Ingberg, senior engineer, Bureau of Standards, Washington, D. C., and "Building Code Revision Work on the Pacific Coast," by J. E. Mackie, secretary Pacific Coast Building Officials' Conference.

THE SECOND ANNUAL CENTRAL STATES SAFETY CONGRESS will be held in Kansas City again this year, the dates set being April 23-25. The program will include talks by the governors of Texas and Kansas, Dan Moody and Ben S. Paulen; Mayor Albert I. Beach of Kansas City; Mayor George Leach of Minneapolis; City Manager Fry of Oklahoma City, and representatives of other cities and states.

THE AFFILIATED TECHNICAL SOCIETIES OF BOSTON will hold its final meeting of the season on April 18. The subject to be considered is "Traffic Control," and the speaker will be E. W. James, chief of the bureau of design, U. S. Bureau of Public Roads.

Obituary

DELOS FRANKLIN WILCOX, an authority on public franchises and public utilities and former deputy water commissioner of New York City, died on April 4 from pneumonia after a brief illness. He was educated at the University of Michigan and Columbia University and in 1897 came to New York to become chief of the bureau of franchises of the Public Service Commission for the First District, which was then being organized. He entered private practice as a public utility expert in 1913 and the following year was appointed deputy water commissioner by Mayor Mitchel. He was the author of many books dealing with the problems of city government and the regulation of public utilities. He frequently advocated municipal ownership of traction lines.

O. N. HANSFORD, county engineer, Pueblo, Colo., died on April 4. Mr. Hansford had served only eighteen months. He was 56 years old.

BERTRAND THORP WHEELER, chief engineer of the Maine Central Railroad since 1912, died on March 20. Mr. Wheeler was born in Lempster, N. H., on Nov. 25, 1863, and was graduated from Dartmouth College in the class of 1884. After his graduation he became assistant engineer of the Old Colony Railroad, and retained this position when that railroad became part of the New Haven system. In 1902, he was superintendent of streets of the city of Boston. He returned to railroad work in 1902 and until Nov. 1, 1912, served as engineer of construction with the New Haven Railroad. On the latter date he became chief engineer of the Maine Central. He was also chief engineer of the Portland Terminal Company.

JOSEPH W. BOYD, for many years professor of higher mathematics and astronomy at the North Georgia Agricultural College, died on April 1 in Atlanta. When the Georgia state highway department was organized, Professor Boyd was made assistant state highway engineer and did much to promote the building of roads in Georgia.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Standards for Concrete Building Units to Remain Unchanged

The simplified practice recommendation concerning concrete building units has been reaffirmed by the standing committee of the Bureau of Standards without change for a period of one year. A survey covering the year 1927 was conducted under the auspices of the Portland Cement Association. Manufacturers of concrete block, concrete tile and concrete brick, to the number of 4,198, representing 90 per cent of the total production and 85 per cent of the firms engaged, contributed data which indicated that the average degree of adherence to the recommendation was 90 per cent.

Business Notes

HERBERT M. HEIN has recently assumed the management of the water meter exports of the Hersey Manufacturing Company, Boston, Mass. Mr. Hein will make his office in New York City.

BATES VALVE BAG CORPORATION, Chicago, announces that J. I. McCants has become affiliated with the company in the capacity of southern sales manager. Mr. McCants has been engaged in the cement business in the south since 1905. For 12 years he was general sales manager for the Standard Portland Cement Co., Birmingham, this company later being sold to the Atlas Portland Cement Co. After retailing building materials, he was for a period general sales manager of the Signal Mountain Portland Cement Co., Chattanooga, Tenn. The Bates Valve Bag Corporation has recently established a factory at Birmingham, Ala., to supply the needs of its southern customers.

C. O. BARTLETT & SNOW COMPANY, Cleveland, announces that it has appointed W. H. Norrington as its representative in New York City, with offices at 30 Church St. Since 1914 Mr. Norrington has been with the Robins Conveying Belt Company, holding since 1921 the position of general sales manager.

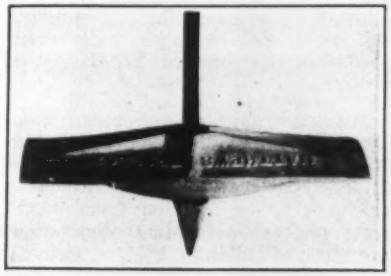
SERVICISED PRODUCTS CORPORATION, Chicago, has doubled its plant capacity over that used in 1927 and acquired property at New Orleans for the manufacture and distribution of expansion joint material at that point. In addition to its regular expansion joint material, bridge flooring, railroad crossing planks, industrial flooring and other building products, the company is manufacturing two new expansion joints, one with felt sides and a matted felt fiber core, and one known as a cork seal joint made up of 75 per cent asphalt, 18 per cent ground cork and 7 per cent fiber, for use primarily in buildings where high resiliency is required.

BOWEN MACHINERY COMPANY, Philadelphia, has been organized by R. Bowen, formerly general sales manager of the T. L. Smith Company, Milwaukee. The company will handle contractors' and industrial equipment, its office and warehouse being at Delaware and Fairmount Avenues.

AMERICAN ROLLING MILL CO. has ordered a 100-ton oil-electric locomotive for service at its Middletown, Ohio, plant. The locomotive is a joint product of the Ingersoll-Rand Co., the General Electric Co., and the American Locomotive Co. A few months ago the American Rolling Mill Co. bought a 60-ton oil-electric locomotive for yard work in its plant at Ashland, Ky. In the 100-ton locomotive there are included two 300-b.hp. oil engines. Four motors are used geared to the driving wheels. It is said that the excellent showing of the 60-ton locomotive resulted in the order of the larger unit.

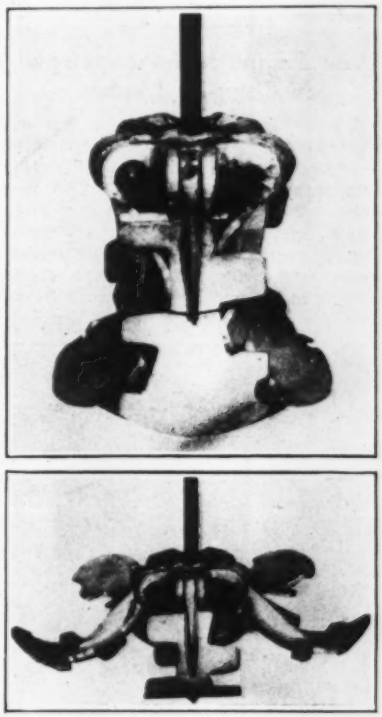
Guy Wire Anchors in Two New Types

A new plate type anchor and a new expanding type anchor, each available in several sizes, have recently been put on the market by the W. N. Matthews Corporation, St. Louis. The plate anchor is known as the Traplox anchor and consists of a rod and plate attached to each other through a ball and socket joint which is claimed to eliminate concentration of the entire stress at two points at the joint as is the case with some plate type anchors; instead it distributes this stress about the periphery of the joint. Standard N.E.L.A. or A.T. and T. guy rods with either a rolled or cut thread are used, although forged point rods used with other plate type anchors are also adaptable. The anchors are supplied with a special driving point. The Traplox anchors are made in three sizes, No. 90, 120 and 160. These numbers denote the approximate area of the plate in square inches.



NEW PLATE TYPE ANCHOR

The expanding type anchor is shown in the accompanying illustration in both the closed and open position. The anchor is so designed that it can be expanded very quickly, the push on the expanding blades being from the inside out. The blades have a sharp edge all the way around and this greatly assists the expanding motion. An exclusive feature of this Xpandix type anchor is the ability to recover the rod when it is desirable to abandon the anchor.



NEW EXPANDING TYPE ANCHOR IN CLOSED AND OPEN POSITIONS

These expanding type anchors are made of malleable iron in two sizes, the No. 8 and the No. 20, the No. 20 being illustrated. The No. 8 when expanded has a spread of 13½ in., and the No. 20 a spread of 19½ in. Both anchors are designed to be inserted in an 8 in. hole.

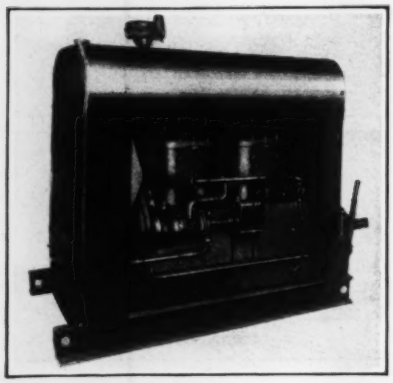
Gas-Electric Drive for Trucks

Gas-electric drive, which has largely been confined in automotive applications to the driving of buses and snow plows, is being used on 19 gas-electric trucks owned by the Philadelphia Rural Transit Company. The trucks were manufactured by the Walter Motor Truck Company, Long Island City, N. Y., and were put into operation as snow plows with provision for operation as trucks during the warmer months. With a

chassis weight of 12,000 lb. and a trailer and load weight of from 16,000 to 20,000 lb., it is claimed that the trucks can maintain a free running speed of over 25 m.p.h. with the motors in parallel; with the motors in series the trucks can operate through soft ground with practically no temperature rise. It is said that out of a total of 27,491 miles of gas-electric truck operation over a period of three months, no road failures or engine trouble occurred. Other gas-electric trucks have recently been put in service by the General Electric Company, one in its Baltimore factory, this also being manufactured by Walter, and one, a 2½-ton Mack, at its Lynn works.

New Engine Series Developed in Compact Models

A new line of industrial gasoline engines known as series "A" has been developed by the Continental Motors Corporation, Detroit, Mich. The new series provides a power range of from 5 to 96 hp. It consists of a transformation of several of the company's present power units, by changing the entire housing to lesser dimensions for the purpose of making them more compact.

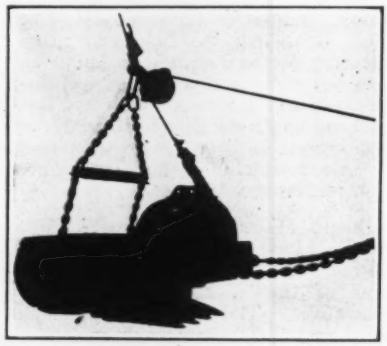


Many new features made possible through these dimensional changes also are added. The accompanying illustration shows the model P-52 of this series, which consists of a four cylinder vertical head type engine with a 5 in. bore and 6 in. stroke, making it the largest of the company's fours. The total piston displacement is 471.2 cu.in. It is a slow speed engine, capable of developing 52.5 hp. at its recommended governed speed of 1100 r.p.m.

New Heavy-Duty Dragline Buckets Fabricated by Welding

New dragline buckets, ranging in size from ¾ to 1¼ cu.yd., have been announced by the Harnischfeger Corporation, Milwaukee, Wis. The new buckets are designed to withstand severe service, the bottom and sides being shaped from a single piece of heavy tank steel with all seams electrically welded. Welded construction provides a smooth inside surface, and prevents sticky soil or weeds from clinging to the bucket. The bucket teeth are heavy steel forgings bolted through the cutting lip and bottom of the bucket. The design includes a large box-section hood and heavy Z-bar supports which are claimed to prevent the sides of the bucket from drawing together at the front end.

The drag chain clevis is provided



with lugs which pull against shoulders in the hitch plate, thereby transmitting the pulling stresses direct from the bucket to the chain instead of through the connecting pin. The pin merely acts as a guide and is not subject to bending strains. It is also claimed that this type of hitch plate makes adjustment of the cutting angle simple.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL ASSOCIATION OF RAILROAD TIE PRODUCERS, St. Louis, Mo.; Annual meeting, Hot Springs, Ark., April 24-26.

AMERICAN WATERWORKS MANUFACTURERS ASSOCIATION, New York City; Annual meeting, San Francisco, Calif., June 11-14.

New Publications

Irrigation Power—WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., has published a new booklet entitled "The Modern Power for Irrigation," giving complete information on estimating and installing electrically driven pumps under many conditions encountered on irrigation projects.

Calcium Chloride in Concrete Construction—SOLVAY SALES CORPORATION, New York City, has devoted a new 31-page booklet to the use of its Solvay calcium chloride in various types of concrete construction. Many illustrations are given of buildings, bridges, terminal construction, and other work in which calcium chloride has been used. The effects of calcium chloride on concrete are considered, the possibilities of using a lower water-cement ratio is discussed, and recommended methods of curing are pointed out. The manner in which calcium chloride imparts such advantages as early strength, waterproofing qualities, etc., is considered. Directions and specifications for use are given.

Heavy Haulage—FRUEHAUF TRAILER COMPANY, Detroit, has published a booklet illustrating its various types of heavy duty trailers for transporting such construction machinery as mixers, ditchers, steam shovels, road rollers and for moving bridge girders, engines and other heavy machinery. The capacities vary from 10 to 60 tons.

Surveying—W. & L. E. GURLEY, Troy, N. Y., have published a small pamphlet entitled "The City Survey." The text consists of an article by R. H. Randall, of R. H. Randall & Company, Inc., geodetic and topographic engineers, Toledo, Ohio. It considers the standards and practices of the city survey, touching on such subjects as triangulation, traversing, leveling and the making of topographic property and wall maps. The use of aerial maps as supplementary aids is considered.

Power Shovels—INDUSTRIAL BROWN HOIST CORPORATION, Cleveland, Ohio, in its new booklet, No. 281, illustrates and describes the power shovels and cranes which now constitute its line. The booklet contains working diagrams and tables of working ranges for all models of the company's machines.

Excavating Machinery—OSGOOD COMPANY, Marion, Ohio, has published a new bulletin, No. 2707, covering its line of gasoline and electric machinery. This line includes power shovels and cranes with the various attachments in common use. Drawings giving working dimensions are included for all types and models of machines.

Seawalls and Bulkheads—SHORE-LINE BUILDERS, INC., Jacksonville, Fla., has published a pamphlet describing its Weber system of constructing seawalls and bulkheads of special shaped precast concrete units. A number of illustrations are included, showing the manner of using the slabs and of installing the steel rail foundation piling.

Hydraulic Operation of Machinery—AMERICAN FLUID MOTORS COMPANY, Philadelphia, Pa., has recently published its catalog "C" of 31 pages in which the use of its Hele-Shaw hydraulic pumps and motors as applied to various types of machinery is considered. Such applications are illustrated and described as presses, testing and pressing machines, cranes and hoists, steering gear, windlasses and hoists aboard ship, steel mill machinery, pipe-testing machines and turntables. Several pages are devoted to the construction and operation of the pump, the motor and the control. Tabular data are given of the sizes of pumps and motors available.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Bond Offerings Second Largest This Year

Total bond offerings during the week ended April 5, 1928, were exceeded by only one other week this year and by only one week in the corresponding period of 1927. The value of offerings was $242,810,000, about $163,000,000 more than those in the preceding week and $45,000,000 above those in the corresponding week in 1927. The week of March 2, 1928, which was the record week to date, included the $100,000,000 St. Louis-San Francisco Railway issue and $52,000,000 New York City 4s. Several of the recent outstanding issues were: $50,000,000 American Gas & Electric Company, $25,000,000 New England Power Association, $11,000,000 Chicago Sanitary District and $55,000,000 Kingdom of Denmark 4½s.

Public utilities were the outstanding group for the first week of April. These issues comprised 40 per cent of the total, and foreign bonds were 27 per cent. The last week of March showed the smallest total this year, with only $19,986,000 new issues offered. Of this total, foreign bonds formed about 50 per cent.

The first quarter of 1927 compared with a year ago shows larger offerings for all groups except railroad, public utility and miscellaneous. Foreign issues are in the lead this year, and in 1927 the largest offerings were public utility bonds.

FIRST QUARTER BOND OFFERINGS
(Millions of Dollars)

	1928	1927
Railroad	213.10	220.68
Public utility	350.06	480.97
Industrial	302.71	270.65
Municipal	226.62	206.82
Foreign	452.20	364.52
Real estate	87.95	73.33
Miscellaneous	45.00	88.00

Bond sales during March, 1928, were $319,900,000, or about 1 per cent higher than a year ago. The average yield of 40 bonds in March this year was 4.13 per cent, compared with 4.241 per cent last year.

A number of the more important offerings are listed in the tabulation in the adjoining column.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended April 12, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
Apr. 12, 1928	**$32,011**	**50,387**	**82,398**
Apr. 5, 1928	24,531	43,422	67,953
Apr. 14, 1927	18 232	32,113	50,345
Jan. 1, to date:			
1928	$298,290	642,856	941,146
1927	259,491	484,700	744,191

E. N.-R. Index Numbers

Cost		Volume	
Apr. 1, 1928	**206.40**	**March, 1928**	**318**
Mar. 1, 1928	204.65	February, 1928	225
Apr. 1, 1927	209.00	March, 1927	226
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913	100.00	1913	100

RECENT IMPORTANT BOND OFFERINGS

		Interest Rate	Yield
Public Utility:			
American Gas & Electric Co	$50,000,000	5	4.95
New England Power Association	25,000,000	5	5
Vicksburg Bridge & Terminal Co	5,000,000	6	6
Texas Water Utilities Company	1,000,000	6	6
Minnesota Power & Light Co	14,000,000	4½	4.64
Central States Edison Company	1,350,000	5½	5½
Community Water Service Co	2,500,000	5½	5.67
Industrial:			
Holly Sugar Corp	6,500,000	6	6
California Consumers Company	3,750,000	6	6.12
New York Dock Co	10,000,000	5	4½@5.40
Municipal:			
North Carolina	5,000,000	4	3.90
San Francisco	2,600,000	5	4@4.05
Pacific Coast Joint Stock Land Bank	1,500,000	5	4.65
Chicago Sanitary Dist.	11,000,000	4½	3.80@4
East Bay Municipal District	3,000,000	5	4.20
Tonawanda, N. Y., (school)	700,000	4	4.10
Multonomah Co., Ore. (school)	725,000	4	....
Foreign:			
Republic of Colombia	35,000,000	6	6.35
Kingdom of Denmark	55,000,000	4½	4.80
R. C. Church Welfare Inst. in Germany	3,000,000	7	7.10
Famous Players Canadian Corp.	3,000,000	6½	6½
Rio de Janeiro	1,770,000	6	....

Relative Values in Five Public Utility Groups Shown for 15 Years

Comparison of Variations in the Main Items Making Up Physical Values

By C. F. Lambert

Burns & McDonnell Engineering Company, Kansas City, Mo.; Los Angeles, Calif.

RELATIVE costs of five public utilities reflecting year-to-year price valuations and relative proportion of main components are here tabulated and charted. Charts showing data from 1913-1924 were published with the first article on this subject in *Engineering News-Record* of May 7, 1925.

Curve No. 1 shows the relative yearly value of power plant buildings, and separately for labor and material in the proportion in which each enters into the cost of a power plant building or pumping station.

Curve No. 2 and Table I show the yearly value and five- and ten-year averages for water-works systems. These figures are based on 25 systems in various parts of the United States, and on 68 separate items going to make up the total.

Curve No. 3 and Table II show the same information for electric light plants. These figures are based on 25 systems, and on 84 separate items going to make up the total.

Curve No. 4 and Table III show the same information for street railway systems, these figures being based on ten systems and 82 separate items.

Curve No. 5 and Table IV, for natural gas systems, are based on eleven systems and 58 separate items.

RELATIVE YEARLY VALUES OF MAIN ITEMS ENTERING INTO PHYSICAL VALUES OF FIVE PUBLIC UTILITIES—1913 = 100

Table I—Water-Works Plants

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Land	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Buildings	11.2	10.8	11.1	13.3	16.5	18.5	20.6	25.6	20.9	19.0	20.8	20.7	20.6	20.7	20.2
Equipment	12.1	12.0	14.0	17.3	22.6	23.4	24.3	26.0	23.4	21.8	22.9	23.0	22.9	22.7	22.5
Distribution	72.7	67.1	71.3	94.1	143.2	161.1	165.8	197.8	155.8	130.1	149.8	152.2	143.2	140.5	127.5
Misc.	1.1	1.1	1.1	1.4	1.8	2.0	2.3	2.8	2.2	2.0	2.2	2.0	2.1	2.0	1.9
Total	100.0	93.9	100.4	129.0	187.0	207.9	215.9	255.1	205.2	175.8	198.6	200.8	191.7	188.8	175.0

Table II—Electric Light Plants

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Land	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Buildings	10.1	9.7	10.0	12.0	14.9	16.7	18.5	23.1	19.9	17.1	18.8	18.6	18.5	18.6	18.2
Equipment	38.9	36.7	36.7	47.9	73.5	79.5	81.0	86.7	84.6	75.1	73.4	73.5	73.6	73.0	72.0
Distribution	44.8	43.5	47.1	56.1	63.4	69.6	75.2	82.6	77.4	70.4	70.4	69.6	70.9	71.2	71.1
Misc.	3.4	3.4	3.4	4.1	5.1	6.0	6.8	8.6	6.8	6.2	6.2	6.1	6.1	6.0	5.7
Total	100.0	96.1	100.0	122.9	159.7	174.6	184.3	203.8	190.5	171.6	171.6	170.6	171.9	171.6	167.0

Table III—Street Railway Systems

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Land	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Buildings	4.7	4.5	4.6	5.6	6.9	7.8	8.6	10.8	8.8	8.0	8.8	8.7	8.6	8.6	8.5
Track Const.	64.3	63.1	63.4	71.9	83.3	104.8	113.8	144.1	119.9	105.4	113.6	112.8	110.2	110.2	108.6
Span Const.	5.8	5.4	6.3	8.7	9.9	9.7	10.0	11.1	9.0	8.5	8.7	8.8	8.1	8.0	8.1
Cars & Equip.	20.9	22.4	22.8	25.1	27.2	31.1	44.4	61.1	59.1	53.0	47.0	42.9	40.7	40.7	40.7
Misc.	1.7	1.6	1.6	2.2	2.9	3.2	3.5	4.3	3.6	3.2	3.3	3.2	3.2	3.2	3.1
Total	100.0	99.6	101.3	116.1	132.8	159.2	182.9	234.0	203.0	180.7	184.0	179.0	173.4	173.3	171.6

Table IV—Natural Gas Plants

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Land	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Buildings	1.6	1.5	1.6	1.9	2.4	2.6	2.9	3.7	3.0	2.7	2.9	2.9	3.0	3.0	2.9
Equipment	1.7	1.6	1.8	2.6	4.0	3.6	3.5	4.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0
Distribution	92.2	89.9	92.0	111.0	155.7	182.9	186.5	202.4	187.3	158.4	168.7	173.2	175.0	174.6	169.9
Misc.	2.9	2.8	2.9	3.3	4.4	5.1	5.8	7.8	6.4	5.6	5.9	5.7	5.5	5.4	5.3
Total	100.0	97.4	99.9	120.4	168.1	195.8	200.3	219.6	201.4	171.4	182.2	186.5	188.1	187.6	182.7

Table V—Artificial Gas Plants

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Land	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Buildings	6.8	6.5	6.7	8.1	10.0	11.2	12.5	15.5	12.7	11.5	12.6	12.5	12.4	12.5	12.2
Equipment	30.4	29.1	33.1	49.9	76.4	68.7	67.2	75.9	66.1	62.8	63.4	61.2	60.5	60.6	60.3
Distribution	56.5	54.4	55.6	68.0	98.3	114.8	116.5	130.4	115.6	98.2	107.5	108.6	107.3	106.7	101.5
Misc.	2.1	2.1	2.1	2.5	3.1	3.6	4.1	5.5	4.6	4.1	4.2	4.0	3.9	3.8	3.8
Total	100.0	96.3	101.7	132.7	192.0	202.5	204.5	231.5	203.2	180.8	191.9	190.5	188.3	187.8	182.0

Curve No. 6 and Table V, for artificial gas systems, are based on 25 systems and 63 separate items going to make up the total.

Curve No. 7 shows the relative value of the five different utilities.

As recent government figures show relative values based on 1926 values as 100 per cent, Table VI has been prepared, giving 1913 to 1927 values on this basis.

Business Notes

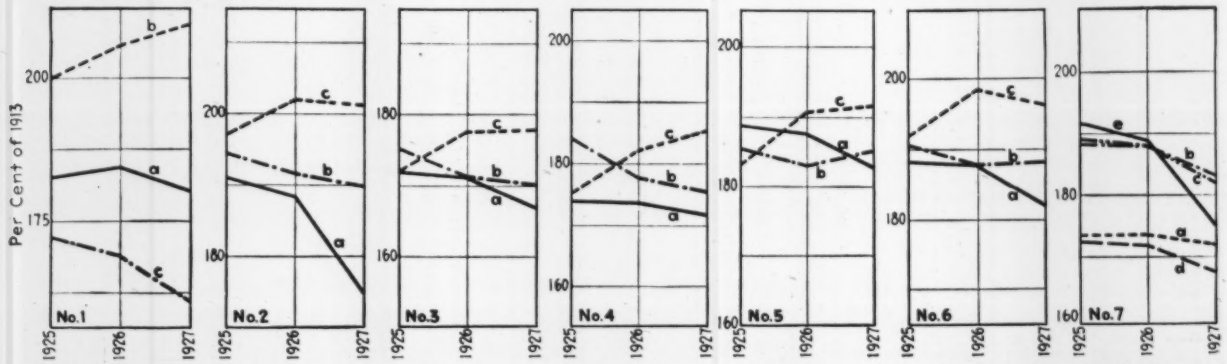
The percentage of the U. S. Steel Corporation's gross earnings used in the payment of direct wages reached a high point of 48.9 in 1924. In 1926 43.6 per cent was paid and last year an increase to 45.5 per cent was shown. General expense amounted to 28 per cent of gross earnings in 1924 and 31.5 per cent in 1927.

Only eleven of the index numbers published weekly by the Department of Commerce are now available for the entire month of March. Compared with average indexes for March, 1927, cotton receipts, iron and steel composite price and Federal Reserve ratio of reserve to deposits were lower. Cotton price, Fisher's price index, bond and stock prices and interest rates on both call and time money were higher than last year. Total bank loans and discounts, bank debits and business failures were also higher. These index numbers have the average for 1923-25 for the base. The three items that were more than 20 per cent above the base are bank loans and discounts, bank debits and business failures. Indexes for items which are lower than 100 are cotton receipts and price, iron and steel price, Fisher's price index and the Federal Reserve ratio. The February, 1928, index of production of raw materials was below both that for January, 1928, and that for February, 1927. Manufacturing production activity was higher than both a month ago and a year ago, according to Department of Commerce reports.

In general it may be said that the industries covered by McGraw-Hill publications are operating at a slightly higher level than at this time last year. This is especially true of the construction industry, the metal-working industry and the electric light and power industry. Preliminary figures on electrical energy consumption, says R. M. Davis, indicate that the rate of operations in general industry for March was about on the same level as last year, possibly 1 or 2 per cent above.

Table VI—Relative Values Based on 1926 as 100 Per Cent

	1913	1923	1924	1925	1926	1927
WATER WORKS						
Land	1.5	1.5	1.5	1.5	1.5	1.5
Buildings	5.9	11.0	11.0	10.9	11.0	10.7
Equipment	6.4	12.1	12.2	12.1	12.0	11.9
Distribution	38.6	79.3	80.6	75.8	74.4	67.5
Miscellaneous	0.6	1.2	1.1	1.1	1.1	1.0
Total	53.0	105.1	106.4	101.4	100.0	92.6
ELECTRIC LIGHT PLANTS						
Land	1.6	1.6	1.6	1.6	1.6	1.6
Buildings	5.9	10.9	10.8	10.8	10.8	10.6
Equipment	22.7	42.8	42.8	42.9	42.5	41.9
Distribution	26.1	41.0	40.5	41.3	41.6	41.4
Miscellaneous	2.0	3.6	3.6	3.6	3.5	3.3
Total	58.3	99.9	99.3	100.2	100.0	98.8
STREET RAILWAYS						
Land	1.5	1.5	1.5	1.5	1.5	1.5
Buildings	2.7	5.1	5.0	5.0	5.0	4.9
Track construction	37.1	65.5	65.1	63.6	63.6	62.7
Span construction	3.3	5.0	5.1	4.7	4.6	4.7
Cars and equipment	12.1	27.1	24.8	23.5	23.5	23.5
Miscellaneous	1.0	1.9	1.8	1.8	1.8	1.8
Total	57.7	106.1	103.3	100.1	100.0	99.1
NATURAL GAS PLANTS						
Land	0.9	0.9	0.9	0.9	0.9	0.9
Buildings	0.9	1.5	1.5	1.6	1.6	1.5
Equipment	0.9	1.7	1.7	1.6	1.6	1.6
Distribution	49.1	89.9	92.3	93.3	93.0	90.6
Miscellaneous	1.5	3.1	3.0	2.9	2.9	2.8
Total	53.3	97.1	99.4	100.3	100.0	97.4
ARTIFICIAL GAS PLANTS						
Land	2.2	2.2	2.2	2.2	2.2	2.2
Buildings	3.6	6.7	6.7	6.6	6.7	6.5
Equipment	16.2	33.8	32.6	32.2	32.3	32.1
Distribution	30.1	57.2	57.8	57.1	56.8	54.0
Miscellaneous	1.1	2.2	2.1	2.1	2.0	2.0
Total	53.2	102.1	101.4	100.2	100.0	96.8



No. 1
a. Power plant building cost
b. Building labor
c. Building material

No. 2
a. Waterworks—yearly value
b. 5-year average
c. 10-year average

No. 3
a. Electric light plants—yearly value
b. 5-year average
c. 10-year average

No. 4
a. Street railways—yearly value
b. 5-year value
c. 10-year value

No. 5
a. Natural gas—yearly value
b. 5-year value
c. 10-year value

No. 6
a. Artificial gas—yearly value
b. 5-year average
c. 10-year average

No. 7
a. Street railways
b. Natural gas
c. Artificial gas
d. Electric light
e. Waterworks